THE

CONSTRUCTION

OF

TIMBER,

From its EARLY GROWTH;

Explained by the

MICROSCOPE,

And proved from

EXPERIMENTS,

In a great VARIETY of KINDS:

IN FIVE BOOKS.

On the PARTS of TREES; their VESSELS; and their INCREASE by GROWTH: And on the different DISPOSITION of those PARTS in various KINDS; and the PARTICULARITIES in their VESSELS.

WITH FIGURES OF

Their various APPEARANCES; of the INSTRUMENT for cutting them; and of the MICROSCOPE thro' which they were viewed.

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M.DCC.LXX.

INTRODUCTION.

IT is propoſed to ſhew the Conſtruction of Timber: the Number, Nature, and Offices of its ſeveral parts; and their various arrangements and proportions in the different kinds: To point out a way of judging, from the ſtructure of Trees, the uſes which they will beſt ſerve in the affairs of life; and of adding ſomething to their ſtrength, and preſervation.

The compoſition of the whole; the variations in the diſpoſition, and the differences in proportion of the ſeveral parts, are, in many of the ſpecies, ſo ſtrange, and in ſome ſo very delicate, that to ſee them diſtinctly there are required pieces of ſuch an extreme thinneſs, and magnifying powers at once ſo great and ſo clear, that it were vain to lead men into an attempt of fol-

lowing the experiments, without firſt acquainting them with the machine by which the pieces were cut; and the Microſcope thro' which they have been viewed.

The Cutting Engine is an invention of the ingenious Mr. Cummings. The two or three firſt were perfected under his own hand; and they are now made for general uſe by Mr. Ramſden.

DESCRIPTION of an INSTRUMENT for cutting Tranſverſe Slices of WOOD, for MICROSCOPICAL OBJECTS.

A A. Plate I. Fig. 1. repreſents *a cylinder of ivory*, three inches and a half long, and two inches in diameter; to the one end of which is fitted

B B. *A plate of bell-metal*; the ſection of which, with the manner of fitting it to the ivory, may be ſeen in Fig. 2. in which the ſeveral parts are marked with the ſame letters as in Fig. 1.

C. is *a plate of braſs*, fitted to the other end of the cylinder; through which and the ivory there

there pafs two long ſcrews, which take into the thick part of the bell-metal B B, ſo as to fix both plates ſtrongly to the ivory; into which they are alſo indented, to prevent ſuch ſhaking as might otherwiſe happen after ſwelling or ſhrinking.

D D. *The Cutter*; whoſe edge is a ſpiral, and the difference of whoſe longeſt and ſhorteſt radii is equal to the thickneſs of the largeſt piece of wood that the inſtrument will take in. The loweſt ſide of this cutter muſt be ground extremely flat and true, in order that all the parts of its edge may be exactly in the ſame plane; and that the middle part of it may be applied cloſely to the flat circular plane left at the center of the plate B B, to preſerve it in the proper direction when carried round by the handle.

All that part of the bell metal, which *the edge of the cutter traverſes*, is turned ſo low as not to touch it, (ſee the Section:) the middle of the cutter is about $\frac{1}{5}$ of an inch thick, and has in it a ſquare hole that fits on the end of a ſteel axis P P, one end of which turns on a pivot in the plate C, the other end in the plate B B. This end has a conical ſhoulder which fits into a hole

of the ſame ſhape in the under ſide of the plate, as repreſented in the Section.

e e. A piece of braſs ſomewhat in the form of an index, which is alſo put on the axis P P: this piece has a round hole in its center ſo large as to admit of its being turned into any poſition with regard to the cutter; and in order to keep it concentric thereto there is left on it a circular projection which fits into a cavity made in the lower ſide of the handle, where it fits on the axis. (See the Section.)

F. *The handle*; which is ſo fitted on the axis P P, that it carries the cutter and the piece *e e* round with it.

G. *A Nut* that ſcrews the handle on its axis, and keeps the cutter flat to the bell-metal B B, when carried round by the handle.

o o o.—Is a hole nearly in ſhape of the ſector of circle, pierced through that part of the bell-metal which the edge of the cutter traverſes, and continued through the whole length of the ivory cylinder, truly parallel to its axis, and of an exactly equal width throughout, till it terminates at the plate *c*.

H. repreſents

THE CUTTING ENGINE

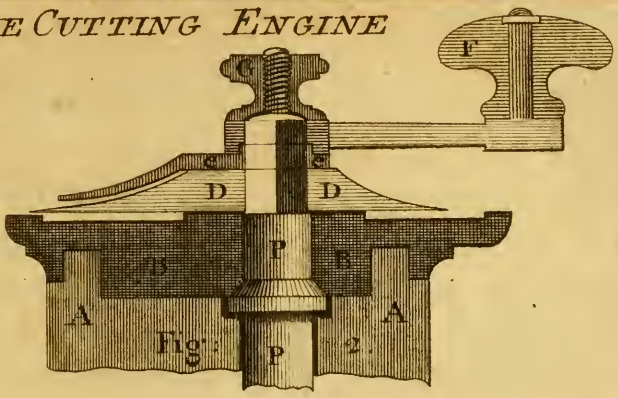


Fig. 2.

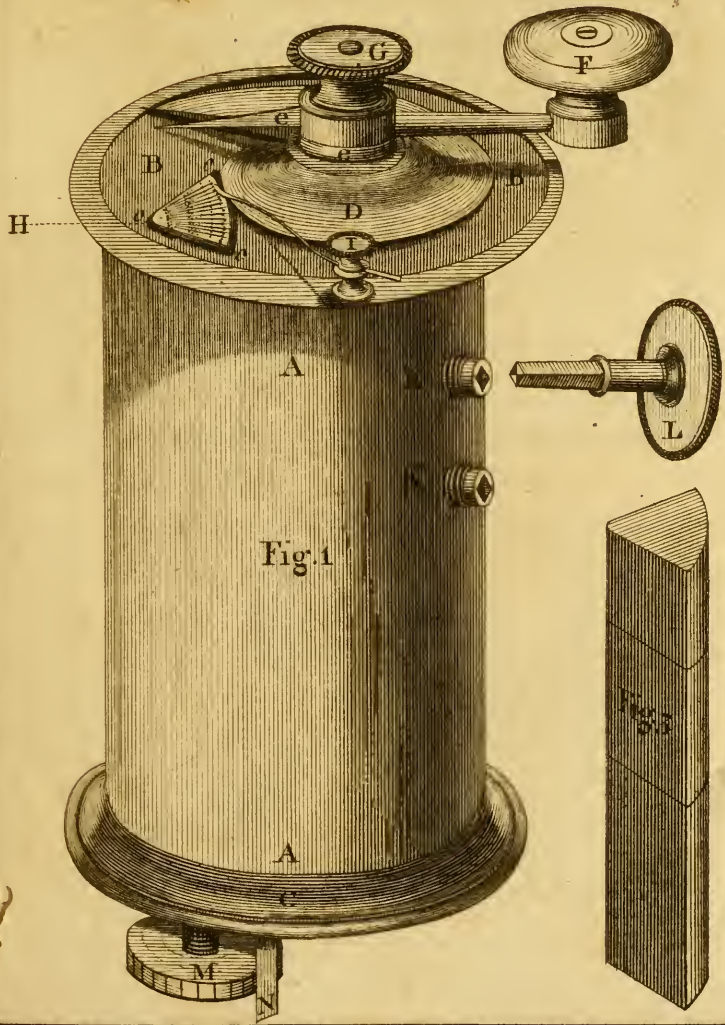


Fig. 1

Fig. 3

H. repreſents *the end of a piece of wood of which ſlices are to be cut*, and which is put into the cavity *o o o*; into the angular part of which it is gently preſſed by means of

K K. *Two braſs ſcrews*, which paſs thro' the ivory into the cavity *o o o*, and are made to preſs on the wood *h* by means of

L. *A key* that fits into hollow ſquares made in the ſcrews K K.

M. *A ſcrew that paſſes thro' the braſs plate* C, oppoſite the middle of the cavity *o o o*; and by means of which the wood *h* is raiſed to the cutter. This ſcrew has forty threads to an inch, and its head being divided into twenty-five equal ſpaces, it is evident that the moving one of theſe diviſions or ſpaces will make the ſcrew advance and raiſe the wood *h* juſt one thouſandth part of an inch.

N. *An index* that points the diviſions on the head of the ſcrew (M). The breadth of this index, from the one fiducial edge to the other, ſubtends a diviſion and a half on the head of the ſcrew; by which means half diviſions as well as whole ones may be accurately ſhifted, and the 2000th, 1500th, 1000th, 750th, &c. parts of an inch truly eſtimated. To render the

effect of this ſcrew the more certain, its point is turned round ſo as to act very near the center, and a piece of ivory (ſee Fig. 3.) is carefully fitted into the cavity *o o o*, ſo as to move freely therein without any lateral ſhake, and to reſt on the end of the ſcrew M. This piece of ivory acting equally on every part of the under ſurface of the wood, will raiſe it towards the cutter with much more certainty than if the ſcrew acted immediately on it. Several ſuch pieces of ivory, of different lengths, (as repreſented by Fig. 3.) ought to be fitted to the inſtrument, ſo as readily to ſuit the length of any given piece of wood. One piece of the full length of Fig. 3. muſt have one end left rough from the file, that pieces of cork, agaric, the pith of wood, and ſuch other ſoft ſubſtances may be cemented on it with ſealing wax; in which caſe they can be cut into ſlices of a determinate thickneſs, as well as wood.

Now if a piece of wood, whether round or of the ſhape repreſented in the inſtrument at (*b*), and of whatever ſuitable ſize, be put into the cavity *o o o*, and gently preſſed into the angular part thereof by the ſcrews K K, let it be raiſed towards the cutter by means of the ſcrew M.

If

If the handle be turned to the right, the edge of the cutter will advance on the wood, and cut off ſuch part as lies above the plane in which the edge of the cutter moves; and when the upper ſurface of the wood is thus rendered flat, ſlices may be cut of any required thickneſs, according to the number of diviſions that the ſcrew M is made to advance. If the machine be made with due care, it will readily cut a thouſand ſlices in an inch; and if the edge be good and very well ſet, ſlices may be cut that are no thicker than the 1500th or even the 2000th part of an inch: but this requires management, much depending on the force with which the ſcrews K K pinch the wood.

It is not an eaſy matter to procure an edge ſufficiently fine for the above purpoſe; but with the very beſt poſſible, thin ſlices have a tendency to curl up into rolls, ſo as to be unfit for the Microſcope; to prevent which, a very ſlender ſpring is made to preſs gently on that extremity of the ſlice where the inciſion begins, ſo as to keep it flat to the cutter: when this ſpring is ſet to its proper poſition, it is fixed to it by the ſmall finger-ſcrew I. And leſt the action of this ſpring ſhould deſtroy the ſlice after it is wholly

wholly cut, and in paſſing over the extremity of the cutter, the piece *e e* (which turns with the cutter) is fixed by the nut G into ſuch a poſition, that in paſſing under the ſpring it raiſes it, and relieves the ſlice at the very inſtant that the cutter has wholly done its office: and thus the ſlices are made to fall into ſpirits of wine, in which they are preſerved for uſe.

In ſome woods the pith ſhrinks ſo very faſt that it is extremely difficult to keep it entire in ſlices that are thinner than 750 to an inch: to remove which imperfection an inſtrument, of the nature above deſcribed, was made to ſhift its own ſcrew at every revolution of the handle, ſo that very little time was left for the pith to ſhrink; as a hundred ſlices could eaſily be cut in a minute, and the pith was as entire as the wood. This inſtrument had an index, which being ſet to the numbers 500, 750, 1000, made it cut ſo many ſlices to an inch. It performed extremely well, but was judged leſs fit for general uſe than that which has already been deſcribed, it being more complex, and liable to diſorder, as well as more difficult to manage.

The

The compoſition of the MICROSCOPE (which was made, by direction of the Noble Perſon who is pleaſed to be the Patron of this Work, and its Author; by Mr. Adams, in Fleet-Street, Mathematical-Inſtrument-Maker to His Majeſty) will be underſtood by the annexed figure. Plate II.

A DESCRIPTION of the VARIABLE MICROSCOPE.

A B C, the body of the Microſcope, contains two eye glaſſes at A, a third near B, and a fourth in the conical part B and C. The end C ſhews alſo one of the magnifiers ſcrewed thereto.

Hence the body of this Microſcope exceeds thoſe hitherto made, which have only three glaſſes; by encreaſing the field of view, and the light; as well as affording an occaſional opportunity of increaſing the magnifying power of each particular object glaſs: which is performed by pulling up the part A E, and the outward tube A B: the firſt ſeparates at A, the other at B.

Another advantage attending this inſtrument is, that any two of the magnifiers may be uſed at the ſame time; in this manner: ſcrew the

button *b* to the part *c* of the button *a*, and then ſcrew both together into the body at C; the magnifier there repreſented being firſt removed.

There are ſeven of theſe magnifiers; two of which are ſhewn at *a* and *b*: alſo ſix ſilver ſpecula, each having a magnifier adapted to the focus of its concavity; one of which is repreſented at *e*; theſe are to be ſcrewed occaſionally to the body at C. Every one of the ſeven buttons, *a b*, may alſo be uſed with any one of theſe ſpecula, by ſcrewing the lower part of the fruſtrum of a cone, which is figured at *d*, upon the prominent ſcrew on the ſilver ſpeculum at *e*, and then ſcrewing the part *c* of any button *b* into its upper end, and all together into the body at C.

Note, The glaſſes are marked 1, 2, 3, &c. and the leaſt number is the greateſt magnifier.

The body of the Microſcope A B C is ſupported by an arm F, into which it may be put or taken out occaſionally, and may be faſtened by the ſcrew *f*. This arm is fixed to the bar G G, which may be raiſed or depreſſed by turning the large ivory head I, (the ſcrew at H being firſt diſcharged.) G G ſlides cloſe to the upper part of the long bar K L, which laſt is firmly fixed

fixed at N and N to the tooth-wheel N O N; this wheel is ſupported by four ſcroles whoſe extremities are connected to an horizontal circular plate *n*, which gives an horizontal motion to the wheel, the bar K L, and every other part of the Microſcope which is connected thereto; the whole being ſupported upon the pillar M by the three feet P P P.

The annexed figure of the Microſcope is delineated from its perpendicular poſition, being that which affords the beſt repreſentation of its ſeveral parts; but there will be no difficulty to conceive, that on turning the key S the pinion that works in the teeth of the wheel N O N will give the bar K L, with the Microſcope and all its appendages, any obliquity or inclination that may be required.

The ſtage, D D D, with a hole T in the middle, is deſigned to place objects on for obſervation; theſe being firſt fixed in an ivory ſlider, No. 1. or upon a ſlip of glaſs, No. 2. or they may be placed upon one of the round glaſſes which are fitted to the hole at T.

The concave mirror Q Q turns vertically on the extremities of the ſemicircle *g*, and horizontally in the cylinder *h*, by which means it may

may be directed ſo as to reflect the light thro' the center of the ſtage at T, and thence thro' the body of the Microſcope to the eye at E.

The ſtage D D hath a conical pin which fits a hole in the ſlider W, in which it may be turned ſideways, ſo as to examine any object too large for the field of view.

The ſcrole *b* R has alſo a conical pin fitted to a hole in the ſlider V.

By means of the ſlider W the ſtage D D may be readily ſet to its proper diſtance from the magnifier in the button at C, and then by turning the large ivory head I, the body of the Microſcope may be brought to its diſtinct focus. If this be not thought quite ſufficient, tighten the ſcrew at H; and then by turning that at X it may be adjuſted to the eye of any obſerver with the greateſt preciſion, and by the help of the ſlider V a proper ſpot of light may be readily obtained.

No. 3. is a cylindrical tube, in which an inner tube *k* is forced upwards by a ſpring: its uſe is to receive an ivory ſlider No. 1. or a glaſs ſlider No. 2. the object being placed in the center of the hole at *m*, and the ſlider put between the plates *h* and *i*. The hollow at *k* is

is to receive a glaſs tube for confining a ſmall water animal, to ſee the circulation of the blood.

If the animalcula in fluids are under conſideration, or any very minute inſect, it will ſometimes be neceſſary to exclude part of the light which is reflected from the mirror Q by putting the cone No. 4. upon the bottom 1 of No. 3. it being firſt put into the ſtage at T.

The nippers, No. 5. are for confining any object, and are to be placed in one of the ſmall holes near the extremities of the ſtage, or in the ſocket *r*, at the end of the chain of balls, No. 6. as the pointed nippers *t*, which hold an opaque object *t v*. The ſtage D D being removed, and one of the ſilver ſpecula ſcrewed to the Microſcope at C, the ſlider W brought near to the ſlider V, the ſtem *x* of the pillar belonging to the chain of balls being put into the hole at W, the balls may be readily managed to give a proper direction to the object *v t*, and the obſerver's back turned to the window, ſo that the reflection from the mirror of the ſky behind or one ſide may fall upon the ſilver ſpeculum, and thence be returned upon that part of the object *t v* which is to be examined.

No. 7. is a box containing ſpare talcs, to ſupply the ivory ſliders.

No. 8. is a double convex lens, to be uſed as a magnifier in the hand.

Laſtly, Remove the body A B C, and put the ſtage D D into its place in the arm F; put the pin of No. 9. into the hole at *z*, in the top of the bar K L; place an object upon the ſtage; and any one of the magnifiers before deſcribed may be ſcrewed into the end *e* of the ſliding bar *e g*.

In this ſtate of our variable inſtrument we have a ſingle Microſcope to which the above apparatus is applicable: three magnifiers are added, to be uſed only in this application.

There are likewiſe added to the apparatus, two glaſs planes broader than that of No. 2. and two others with hollows ground in them.

Alſo a few flat, round glaſſes, of different colours, which fit the hole T in the ſtage D D: and a watch glaſs, fitted to the ſame place, for obſerving the animalcula in fluids;

And a ſet of glaſs tubes,

THE

INSERT FOLDOUT HERE

THE CONSTRUCTION OF TIMBER EXPLAINED BY THE MICROSCOPE.

BOOK I.

Of the conſtituent Parts of TIMBER.

CHAP. I.

Of the Number of Parts in TREES, and the Manner in which they are diſpoſed.

THE compoſition of Wood is beſt ſeen in a Shoot of two years and a half growth: and the moſt diſtinct and pleaſing view of the ſeveral parts, as they lie together, is to be obtained by placing a very thin ſlice, cut tranſverſely from ſuch a Shoot, before the fifth glaſs of the reflecting Microſcope.

Greater Powers, and another Apparatus, will be required for the examination of every part of this compoſition, ſeparate; but before we enter upon that enquiry, it is beſt to take this general view of all together.

The whole Slice conſiſts of ſeveral concentric Circles, of different ſubſtance; with veſſels, alſo of different kinds, interſperſed among them.

The Parts are theſe:

1. The RIND.
2. The BARK.
3. The BLEA.
4. The WOOD.
5. The CORONA, or CIRCLE OF PROPAGATION.
6. The PITH.

Theſe lie immediately within, or under one another: and in, among, and between theſe, are diſpoſed the Veſſels, which feed the whole; and ſome of which contain the juices, that give the Tree its peculiar qualities, and virtues.

Theſe

Theſe Veſſels are of five kinds:

1. The EXTERIOR
2. The INTERIOR } JUICE-VESSELS.
3. The INTIMATE
4. The SAP-VESSELS.
5. The CORONAL.

Of theſe, the firſt are placed between the Rind and Bark;

The ſecond, in the ſubſtance of the Bark;

The third, in the ſubſtance of the Blea;

The fourth, in the ſubſtance of the Wood;

The fifth, in the Corona, or Circle of Propagation.

Beſides theſe greater Veſſels, the ſeveral parts themſelves are vaſcular; but their Tubes are of another kind; and will be conſidered when we examine the conſtruction of thoſe ſeveral parts. Other Glaſſes will be required for this: they ſcarce appear in the preſent View; which is limited ſolely to the arrangement of the conſtituent parts together.

The tree in which theſe ſeveral circles lie in the happieſt way for obſervation, is the Scarlet Oak of America. If a ſlice be cut from a two years and a half Shoot of this tree, in May; the parts and veſſels juſt enumerated will be ſeen as they are repreſented in Plate III. and this with great diſtinctneſs and preciſion. Where this tree is not at hand, ſuch a ſlice of the common Engliſh Oak will very well ſupply its place, the parts lying nearly in the ſame manner.

a repreſents the Rind, dry, and very thin.

b, the exterior Juice-veſſels. Theſe are placed in round cluſters; they are woody; and contain a thin, whitiſh, watery juice, of no taſte.

c, the Bark. This conſiſts of a multitude of filmy bladders, ranged in circles, one behind another: they are elliptic, thin, and browniſh; and they hold alſo a watery juice. They are connected together, and ariſe in theſe circles one behind another.

d, the

d, the interior Juice-veſſels. Theſe are arranged in oval cluſters, a very conſiderable number of them together. They are of many times the diameter of the preceding: their coats are woody; and they contain a thick, gummy, brown juice, of an auſtere, ſtyptic taſte. This gives the virtue to the Oak Bark, as an aſtringent; and its quality, ſo uſeful in tanning animal hides.

e repreſents the Blea. This conſiſts of connected circles, which have, in ſo thin a piece, viewed perpendicularly, a great deal of the appearance of the bladders in the Bark; but they are in reality of a different nature, as we ſhall ſee, when each part is examined ſeparately: theſe circles are indeed tranſverſe ſections of elliptic veſſels, arranged cloſely ſide by ſide together. They are equal in their whole diameter to the bladders of the Bark; but their cavity is much leſs, becauſe their ſides are thick.

f ſhews the intimate, or moſt inward Juice-veſſels of the Oak: they are ſomewhat larger in diameter than the conſtituent veſſels of the Blea;

and they ſtand ſingly, not in cluſters, as the two former: they contain a thick and almoſt concreted brown juice, more auſtere than that in the veſſels of the Bark: and it is from theſe the wood of the Oak poſſeſſes the ſame auſtere and aſtringent qualities with its Bark.

g. In the whole ſpace from *g* 1 to *g* 2 we ſee the Wood. This is compoſed of five concentric circles, terminated by ſo many undulated lines. Theſe are the ſeveral coats of Wood, added from ſeaſon to ſeaſon. It has been ſuppoſed that each circle is the growth of a year; but a careful attention to the encreaſe of wood has ſhewn me, beyond a doubt, that two ſuch are formed each year; the one in Spring, the other ſoon after Midſummer. At each of theſe times the Branch ſhoots out in length; and whenſoever that is done, the Shoot of the preceding ſeaſon gets an additional coat in thickneſs: I ſhall therefore be permitted to call theſe, inſtead of Year Circles, *Circles of the Seaſons*. The Branch from which the preſent ſection was taken, having been of two years and a half growth, there are found in it five ſuch circles.

The

The compoſition of the Wood is of veſſels half obliterated, by the growth of their ſides filling up their cavities inwardly; and ſwelling out in the ſame manner externally. The whole interſtitial ſpace being thus filled up, the very forms of them are by degrees loſt.

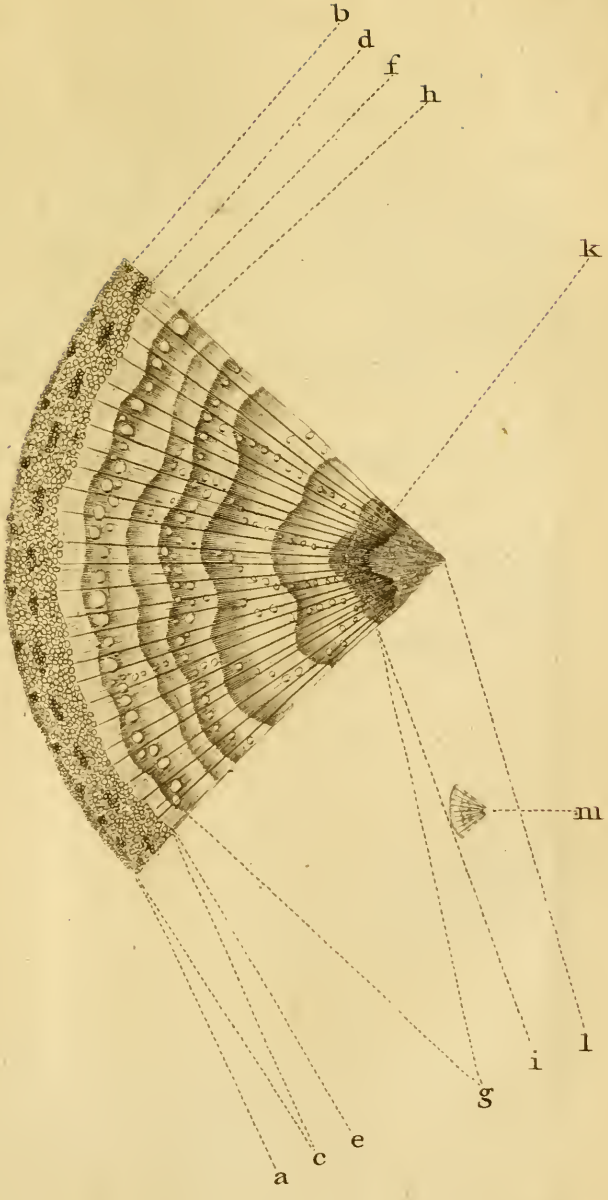
At *b* are ſhewn the Sap-veſſels of the Oak. Concerning which, there have been ſtrange miſtakes. But it is not my purpoſe to point out where others have erred; only plainly to lay down what I have ſeen, and what the objects themſelves are ready to make evident to every one.

Theſe veſſels ariſe in the ſubſtance of the Wood, principally towards the outer edge of each circle. They are very large in the outermoſt coat; and ſmaller in the others: and there are alſo irregular ranges of them, running thro' the thickneſſes of the circles; beſide theſe principal ones of the outer courſe. They have ſolid, and firm coats; and they contain in Spring, and at Midſummer, a limpid liquor, like water, but with a ſlight acidity: at all other ſeaſons of

the year they appear empty, their ſides only being moiſtened with the ſame acid liquor. Thoſe who examined them at ſuch ſeaſons, thought them air-veſſels; and in that opinion, formed a conſtruction for them, which Nature does not avow.

i ſhews the Corona, or Circle of Propagation; a part of the utmoſt importance in the Vegetable Oeconomy; ſince from it ariſe the branches, and encreaſe of the tree: no Vegetable is without it; nor have the figures of thoſe, who have drawn the parts of Plants, failed to exhibit it, as a portion different from all others: yet, till this occaſion, it never had a name. It is in the Oak an undulated circle; and the undulations of all the other circles take their riſe from it. It contains diſtinctly two kinds of veſſels; a larger, *k*, which are pale; and a ſmaller, which are browner; together with an intermediate matter: this laſt is not vaſcular, but compoſed, as the bark, of filmy bladders. The larger order of veſſels contain a ſomewhat acid juice; the ſmaller order, a very auſtere liquor; and the intermediate ſubſtance, pure water.

l repreſents


b
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c
a

l repreſents the Pith. This takes the ſame undulated form in its outline as the Corona, which every way incloſes it: its appearance is very pretty: it ſeems to conſiſt of rings, with ſingle, double, and interſecting outlines; but the reality is otherwiſe. The whole is a compages of little, hollow, white films, arranged, ſide by ſide, acroſs the entire ſpace, and having others of the ſame kind, and form, beneath them; through the whole length of the Shoot.

m ſhews the entire Slice in its natural bigneſs.

Such is the conſtruction of a Shoot, and ſuch the diſpoſition of the ſeveral parts: we may now proceed to their ſeparate examination.

CHAP.

CHAP. II.

The Manner of obtaining the PARTS of a SHOOT ſeparate.

THE enquiry into the ſtructure of each ſeparate part of the Shoot, is a matter of much greater care and attention than the former: I will not ſay, of difficulty; for every thing yields to a determined mind: but time and application will be required. The method I have uſed is this:

In the beginning of April I take a quantity of young branches, from the Scarlet Oak, and other trees. Theſe are firſt cut into lengths, of the growth of different ſeaſons; and then part are left entire, part ſplit, and the reſt quartered. In this ſtate they are put into a wicker baſket, with

with large openings, or of looſe work; and a heavy ſtone is put in with them: a rope is tied to the handle of the baſket, and it is thrown into a brook of running water; at times it is taken up, and expoſed a little to the air; it is frequently ſhook about under water, to waſh off filth; and once in ten days the ſticks are examined.

By degrees, the parts looſen from one another; and, by gentle rubbing in a baſon of water, juſt warm'd, they will be ſo far ſeparated, that a pencil bruſh will perfect the buſineſs; and afford pieces of various ſize, pure, diſtinct, and clean. One part will, in this way, ſeparate at one time, and another at another: but by returning the ſticks to the water, and repeating the operation, in a courſe of four or five weeks, every part may be obtained diſtinct. They are beſt examined immediately; but as one wiſhes to preſerve them for repeated enquiries, it may be done in this manner.

Diſſolve half an ounce of Alum in two quarts of water: drop the pieces, thus ſeparated, for a few moments, into this ſolution; then dry them upon

upon paper, and put them up, in vials of Spirit of Wine. Nothing but Spirit of Wine can preſerve theſe tender bodies; and, till I found this method of hardening them firſt, that liquor often deſtroyed them.

CHAP. III.

Of the CONSTRUCTION of the RIND.

IT has been cuſtomary to diſtinguiſh the two outermoſt coats of a tree by the names Outer, and Inner Rind; but as we have the two words, Rind and Bark, in common uſe, it may be more diſtinct to apply one of them to the one, and the other to the other.

The Rind, or outermoſt coat, being ſeparated from the reſt, and cleaned, appears before the Microſcope like a piece of a white cobweb. It is to be examined, if freſh, in water; if preſerved, in ſome of the Spirit wherein it is kept; being laid in a little ciſtern, hollowed in a ſlip of

of ground glaſs. The happieſt view of it will be had by combining the ſixth and ſeventh magnifiers of the Microſcope here figured.

Although this Rind be by far the thinneſt of all the parts, yet it is compoſed of ſeveral coats; one laid cloſely over another, and all of the ſame kind: the great difficulty is to obtain one of them abſolutely ſeparate. In that ſtate it appears ſcarce more than a ſhadow, or a mere delineation of lines upon the glaſs; but without this, its true conſtruction cannot be known.

The piece of Rind repreſented at Fig. 1, in Tab. IV. ſhews the neceſſity of this exactneſs: the part of it at *a* is one coat only; at *b*, two lie over one another; at *c*, three: in theſe two laſt portions there is a great deal of confuſion: but at *a* the real ſtructure of the part is perfectly diſtinct. It conſiſts of a ſeries of longitudinal veſſels, and a filmy ſubſtance between them. It might ſeem that there are alſo tranſverſe veſſels going at ſmall diſtances from one of the longitudinal ones to another; but this is a deception: a cloſe examination will ſhew, that theſe are only ſpaces between part and part of the film.

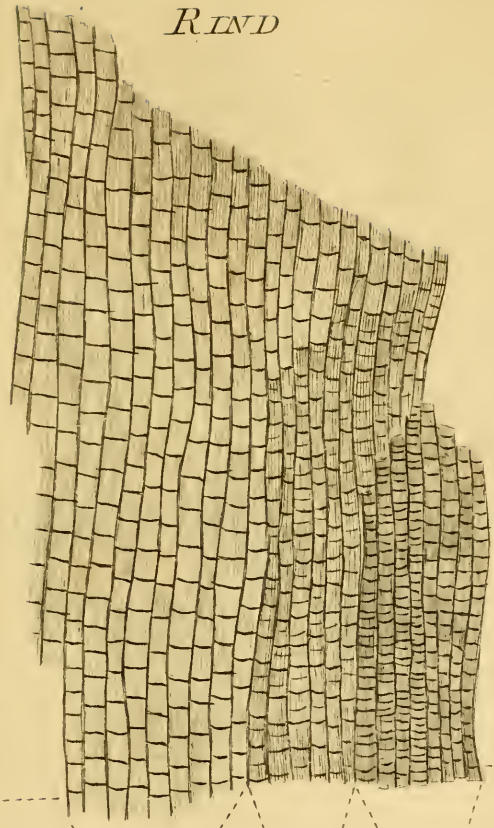
A larger

A larger power of magnifying being uſed, by changing the ſixth for the fourth object glaſs, ſtill keeping on the ſeventh, we ſhall ſee the difference between theſe empty ſpaces and a vaſcular ſtructure, very plainly, as at Fig. 2. *d.*

To underſtand rightly what the filmy part of the Rind is, we muſt return to an examination of the tranſverſe ſection, which was firſt viewed. In this we ſhall ſee, that the parts between veſſel and veſſel repreſent the mouths of open, oval cells: and, referring this appearance to the view here given at Plate IV. Fig. 1. we ſhall underſtand that each film, between ſpace and ſpace, is an oblong bladder; which the knife, in the tranſverſe ſection, has cut through. One of theſe bladders, ſeparate, is repreſented at *f*, Fig. 4. At *g*, Fig. 5. are three or four, with their intermediate ſpaces, and with the longitudinal veſſels continuous between them: this makes a piece of one coat of the Rind; and is a true and exact view of its compoſition. In Herbaceous Plants, two films encloſe the whole; but it is not ſo in Trees.

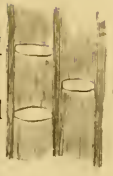
CHAP.

RIND



1 1

a b c



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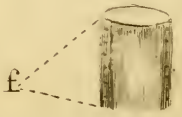


4

5

CHAP. IV.

Of the USES of the RIND.

THE Rind, as thin as it is, and as inconſiderable as it may ſeem, is a part of the vegetable ſtructure, of the higheſt and moſt eſſential uſe: it covers the whole tree, both above; and, what is much more important, under the ground; and contains the great and original organs by which it grows.

To take a right view of its importance and utility we muſt obſerve ſome yet unnoticed parts of its conſtruction: and that theſe may be rendered more diſtinct than in their ſtate of nature, 'tis proper to convey coloured fluids into the ſeveral veſſels. The diviſibility of matter has been often ſpoken of with wonder, but it has

never been manifeſted to the ſenſes in a degree at all to be compared with what is exhibited by ſuch impregnations of vegetable parts.

It may be now obſerved, that at the letter *g* in Fig. 4. there appear dots upon the highly magnified veſſels: but to know what they are requires yet greater powers of the Microſcope, and more aſſiſtance. There are ſcarce any limits to the degrees of magnifying that may be obtained by the combination of two object glaſſes, of different powers, as the conſtruction of this Microſcope admits: nor are the means of more aſſiſtance wanting; ſince coloured liquors may be thrown into the ſmall veſſels of Plants: nay, and into the very ſmalleſt of all, liquors, which tho' pellucid and colourleſs when received, may be coloured after they are lodged there; altho' the matter of that colouring would have rendered the liquid too thick to have paſſed in the ſame condition.

As the veſſels of the Rind are of different diameters in various trees, tho' their conſtruction and that of the Blebs is perfectly the ſame in all; it will be beſt to chooſe for this purpoſe the Rind of

of a tree wherein they are largeſt. The advantages I receive from the garden of her Royal Highneſs the Princeſs Dowager of Wales, at Kew, (who, beſt of Princeſſes and of Women! is pleaſed, undeſerving as I am, to honour me with her royal patronage and protection,) that garden, where every tree that has been ſeen in Europe is at hand; have given me opportunities of ſo many trials, that I can happily ſave the pains of others in this and all the following inſtances; by ſaying what beſt anſwers. To the preſent purpoſe the Rind of the Aſh-leaved Maple is finely ſuited. A piece of this may be obtained of two inches long, and will very ſucceſsfully anſwer the intention. Such a piece being prepared without either alum or ſpirit, but dried from the water in which it had been macerated, is to be impregnated with lead in the following manner; to ſhew the apertures by their colour.

Diſſolve one dram of ſugar of lead in an ounce and a half of water: filter this thro' paper, and pour it into a tea-cup. Clip off a thin ſlice of what was the lower end of the piece of Rind, as it grew on the tree, and plunge it

near an inch deep in the liquor; keep it upright between two pieces of ſtick, ſo that one half or more may be above the water: whelm a wine and water glaſs over the tea-cup, and ſet the whole in a warm place. When it has ſtood two days, take it out, and clip off all that part which was in the liquor, and throw it away.

The circumſtances here mentioned, trivial as they ſeem, muſt be attended to: the operation will not ſucceed even if the covering glaſs be omitted: it keeps a moiſt atmoſphere about the Rind, and makes its veſſels ſupple.

While this is ſtanding, put into a baſon two ounces of quick lime, and an ounce of orpiment; pour upon them a pint and a half of boiling water; ſtir the whole together; and when it has ſtood a day and night, it will be fit for uſe. This is the Liquor Probatorius Vini of ſome of the German chymiſts: it diſcovers lead when wines are adulterated with it; and will ſhew it any where.

Put a little of this liquor in a tea-cup, and plunge the piece of Rind half-way into it.

In

In the former part of this experiment the veſſels of the Rind have been filled with a ſolution of lead; that makes of itſelf no viſible alteration in them: but this colourleſs impregnation, when the Orpiment Lixivium gets to it, becomes of a deep brown: the veſſels themſelves appear ſomewhat the darker for it; but theſe dots, which are real openings, now are ſeen to be plainly ſuch, the colour being perfectly viſible in them, and much darker than in the veſſels. Plate V. Fig 1. *a b.*

This object muſt always be viewed dry, and is beſt kept in one of thoſe Sliders which the Noble Perſon, to whom, in a manner, all that are called my Improvements are originally owing, has directed to be made with glaſſes inſtead of Talcs.

If a piece of the Rind, thus impregnated, be gently rubbed between the fingers till the parts are ſeparated, we ſhall be able in one place or other to get a view of the veſſels all round, and of the films which form the Blebs between them. Theſe laſt conſiſt of mere membrane:

no power of the Microſcope ſhews any thing vaſcular in their ſtructure: they are a kind of bladders, cloſed at bottom and open at the top, with a ſpace, greater or leſs, between the top of one and the bottom of another. Fig. 2. *a a.*

As to the Veſſels, their compoſition is much more to be regarded; they are every where pierced with openings; but of theſe the outer ones firſt ſeen, are by far the largeſt: there are two other ſeries of them; the larger of which, tho' ſtill much leſs than the former, are placed againſt the interſtitial ſpaces, between Bleb and Bleb; and the ſmalleſt open into the Blebs themſelves. Fig. 3. *a b.*

I ſhould think it is not eaſy to err as to the uſes of theſe openings; when we ſee their conſtruction ſo exactly: and thoſe uſes being underſtood, we ſhall have made no ſmall advance in the knowledge of vegetation. Let us, if you pleaſe, philoſophic Reader, conſider them firſt in that part of the Tree which is under ground, the Root: here they are always ſurrounded with ſome degree of moiſture: let us, together with theſe objects, conſider thoſe everlaſting agents heat and cold;

cold ; not to ſay heat in its various degrees, for that were ſpeaking too abſtruſely. Heat can be no where preſent but it expands ſubſtances : cold no where but it contracts them.

We ſee a Root, equalling more than a third part of the Tree above ground, in the extent of its ſurface ; this ſurface is covered with the Rind, thus pierced ; which is connected alſo with the parts underneath it. The cold of winter contracts the whole ; the parts are drawn cloſer together ; and the mouths of theſe innumerable veſſels are ſhut, or nearly ſhut, by this contraction : a little, and but a very little, of the half-congealed moiſture of the ground gets into them. This ſuffices for the ſervice of the Tree, when there is little heat alſo to cauſe perſpiration ; and when in the deciduous Trees, (the far greater part of thoſe of our country) the very organs of the greateſt perſpiration, the Leaves, do not exiſt.

The warmth of ſpring arrives : the fluids of the earth grow thinner, every part of the Root expands ; this opens the mouths of the veſſels, and the torrent of nutrition ruſhes in. A great

deal of it aſcends, but more diffuſes itſelf among the circumjacent parts: the mouths of the ſecond order deliver out a great deal to all the interſtitial ſpace; and thoſe of the third into the Blebs themſelves; and theſe being naturally open, ſoon run over. Thus every part of the Rind, and every coat of it, and even the interſtitial ſpace between its innermoſt coat and the Bark, are filled with a fine fluid; and the whole is ſupple; and it then eaſily ſeparates from the under coverings.

The very courſe and progreſs of the fluid may be ſhewn in this part, even by an eaſier preparation: only that different Rinds muſt be ſought for this purpoſe; the veſſels in ſome being larger than in others. Repeated trials have ſhewn me that the whole progreſs may be eaſily marked in the three following kinds; with only a tincture of cochineal.

Put half an ounce of cochineal in powder into half a pint of ſpirit of wine; ſet it in a warm place, and ſhake it often, for four days; then filter off the clear tincture. Put an inch depth of this into a cup; and ſet upright in it pieces of the Rind of Aſh, White Willow, and Ozier; prepared,

prepared, as has been directed, by maceration in water; for in that way one trouble does for a hundred kinds. Let an inch of the Rinds alſo ſtand up out of the tincture. After twenty-four hours take them out, clip off the part which was immerſed in the fluid, and ſave the reſt for obſervation.

Here is a farther inſtance of the diviſibility of matter. Tho' colour diſappears in a great meaſure under the Microſcope; the more as the power of magnifying increaſes; yet in the firſt of theſe Rinds, that of the common Aſh, the courſe of the veſſels is very diſtinctly and beautifully ſeen by it; for they and they only are crimſon. In this ſpecies the colouring liquor enters only by the open ends of the veſſels; for the mouths at their ſides ſeem too much contracted in the drying to receive it: it aſcends their whole length, and ſhews itſelf at the exterior apertures or mouths, but penetrates no farther. Fig. 4.

In the Willow Rind, ſhewn at Fig. 5. the interſtitial ſpaces, as well as the veſſels, are crimſon: therefore, among the vaſt variety of conſtruction among the Rinds of ſeveral trees,

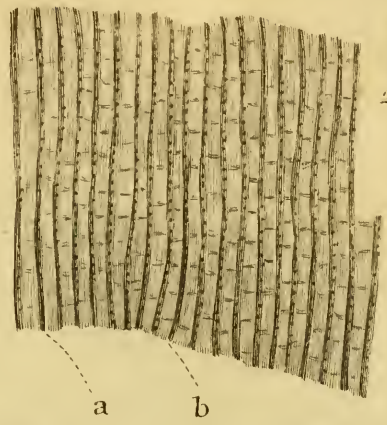
the mouths of the ſecond ſeries are in this larger than in the Aſh. It muſt be ſo; becauſe the colouring liquor was the ſame to both, and only the conſtruction of the body itſelf could in one inſtance have admitted it through paſſages which were cloſed to it in the other.

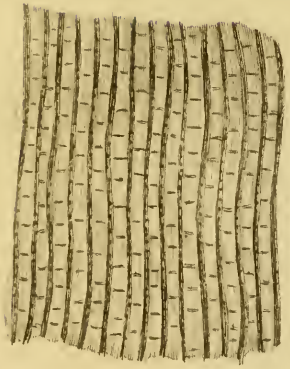
In the Willow, the apertures of the third order ſtill refuſing paſſage to the coloured fluid, the Blebs retained their natural Olive complexion; but 'tis not ſo in the Rind of Ozier, there every ſeries of mouths are open enough to let out the crimſon liquor, and the whole ſubſtance of the Rind is ſtained with it. Fig. 6.

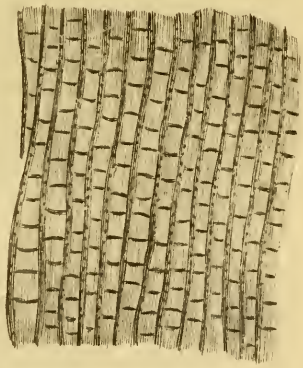
From hence Philoſophy will judge (and it will judge with ſafety) why the leaves of the Aſh appear later than thoſe of the White Willow, and why the Open Ozier precedes even theſe. Elder and Gooſeberry Rinds admit this univerſal tinge more readily than Ozier; but they are not ſo eaſily ſeparated and prepared. The ſame philoſophic truth ariſes alſo here: their texture is the openeſt of that in any Rinds; and 'tis therefore they appear the heralds of the Spring, and harbingers of every other verdure.

CHAP.

RIND WITH FILLD VESSELS







CHAP. V.

Of the BARK.

THE Bark very much reſembles the Rind in its conſtruction: nor can it indeed be otherwiſe; for the Rind was once Bark, and has only ſuffered a ſlight change in ſeparating from it. Happily the conſtruction of this eſſential part is better ſeen in the inner than in the outer coat of Trees; for it is more entire, more perfect; and though, in order of place, the Rind could not but be firſt deſcribed, it may be averred, that unleſs this be firſt viewed, the compoſition of the other will be very difficultly diſtinguiſhed.

The Tree in which I have found the Bark moſt happily formed for preparation, and for obſervation, is the Vine. A piece of this, ſeparated by maceration, and obtained pure and free from every other ſubſtance, appears as at Plate VI. Fig. 1.

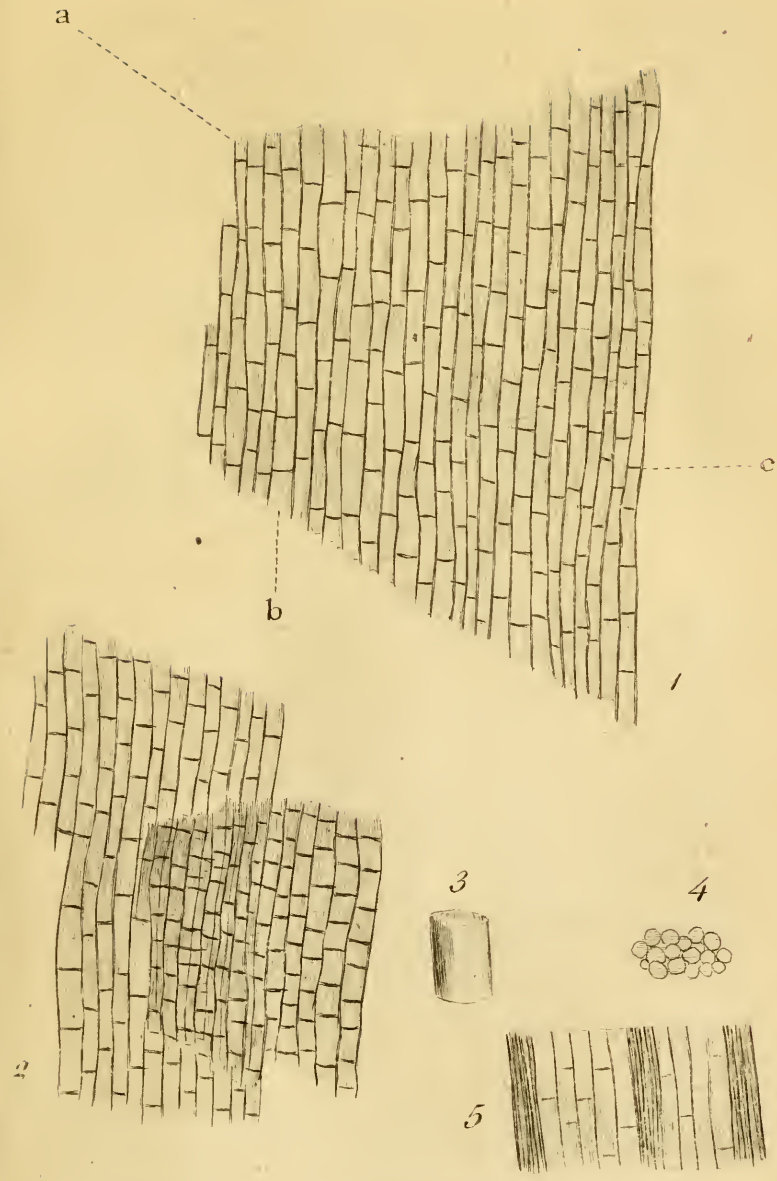
It

It conſiſts plainly of veſſels, *a*; Blebs, *b*; and intermediate ſpaces, *c*. The obvious difference between this and the outer Rind is, that the Blebs are longer, and the veſſels appear more tender. This Bark, which we examine, is one time to be Rind: the Rind that covers it is to fall off; this is to ſeparate from its inner coats, and be expoſed to the air in its place; and in this ſeparation the Blebs ſhrink in their length, and the more immediate contact of the air gives a rigidity to the veſſels.

Little need be ſaid farther of this; the former, which is the ſame ſubſtance in another condition, having been deſcribed at large. It will be plain they are the ſame when the piece is applied to a greater microſcopic power: the mouths of the veſſels are thus ſhewn yet more diſtinctly in this than in the other; becauſe they are here more perfect; and the conſtruction of the Blebs and their abſolute ſeparate diſpoſition is better ſeen, becauſe they ſtand here farther aſunder, the interſtitial ſpaces between Bleb and Bleb having been made ſmaller, as the Blebs were ſhorter by the contraction. Fig. 2.

A Bleb,

Bark



CHAP. VI.

Of the BLEA.

ALTHOUGH the conſtruction of the Bark and Rind in Trees be very much the ſame, there is not that reſemblance between theſe and the next coat underneath; the Blea. This is the part which ſeparates the Bark from the Wood, and is of a middle hardneſs between them; much firmer than the Bark, but ſofter and more juicy than the Wood.

This may be ſeparated as the others, by maceration: and indeed whoever propoſes to himſelf the pleaſure of theſe reſearches, ſhould ſteep a great number of Shoots of the ſeveral kinds of Trees together, that where one fails another may be at hand; and that diſcovery which is withheld in one may be unfolded in another.

It

It is poſſible, with a great deal of care, to ſeparate thin pieces of the Blea from the growing Shoots of ſome kinds of Trees, in early Spring; but when this ſucceeds the beſt it can, 'tis ſtill very much inferior to the other method.

It may not be amiſs firſt to view the appearance of the Blea in a tranſverſe ſection: we ſee that way the parts and their diſpoſition; and may trace them afterwards in their conſtruction. If a piece of the Blea of common Willow be viewed in this way, we ſee that it conſiſts of oval apertures, and a pale but intire interſtitial matter. 'Tis plain the openings are not mere holes, pierced in this intermediate ſubſtance; for we ſee they have thick ſides. They ſeem the eſſential part of the whole; the reſt only a ſomething filling up the interſtitial ſpaces between them, to preſerve the Shoot in its form.

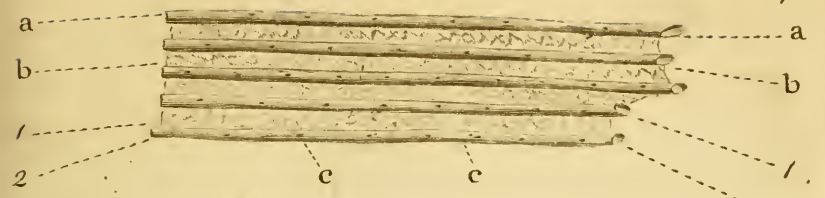
If we now place before the Microſcope a thin, prepared, longitudinal piece of the Blea of the ſame Willow, and apply a ſomewhat larger power than in the preceding view, we find thoſe holes were the apertures of veſſels lodged in that inter-

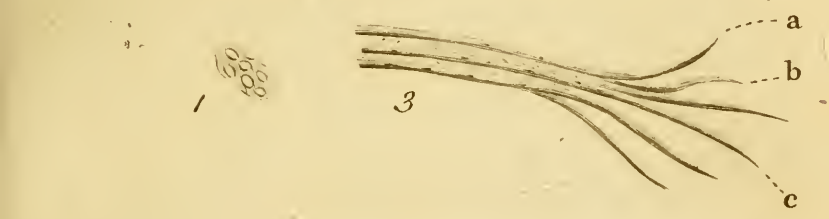
mediate ſubſtance, which is floccoſe, white, and a mere maſs, without form. Upon examining the veſſels carefully, we ſhall perceive that their coats are compoſed of this very floccoſe ſubſtance, only more compactly put together; and that the reſt, which ſeparates them, is nothing more than looſe matter of the ſame kind thrown off from their ſides. The prepared Blea is moſt uſeful in diſcloſing this; for in freſh fragments the veſſels and this ſubſtance ſeem all one common matter.

At Fig. 2. a piece of the prepared Willow Blea is ſhewn as it appears before the Microſcope: *a a* are the veſſels; *b b* is the interſtitial matter.

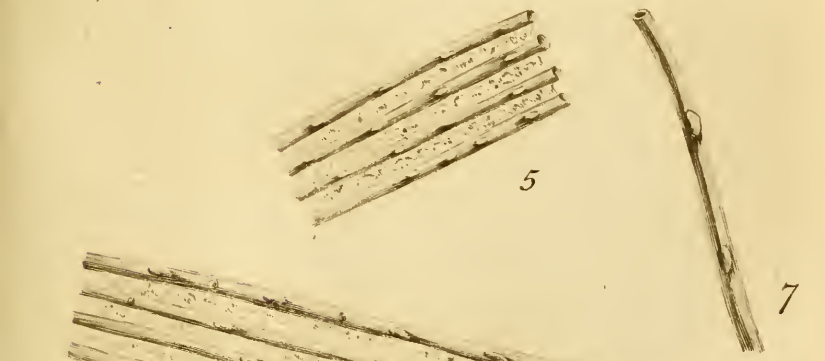
The veſſels of the Blea appear dotted, when ſeen by leſs powerful glaſſes; but here we perceive thoſe dots are ſo many oval ſwellings, like buds on a young branch; but each ſwelling has as it were a mouth opening according to its length. Theſe mouths are innumerable; they appear on every part of the veſſels, and ſerve the purpoſe of keeping the whole in that continual ſtate of moiſture which is ſo eſſential to the growth and encreaſe of it. Fig. 2. *c c.*

He


a
b
1
2
c
c
a
b
1
2


1
3
a
b
c

4
a
b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7

6

He who would ſee this well muſt not only make his preparations carefully, but cut the pieces in a fit ſeaſon; either juſt before the firſt leaves of Spring, or in the Midſummer Shooting time. Then we ſee all the wonders of this ſtructure; the thouſands of mouths which open throughout the courſe of theſe innumerable veſſels, to pour their fluid into the interſtitial matter; which ſwelling with its quantity, like a ſponge with water, preſſes every part outward and upward into growth and thickneſs. It were vain to ſeek them in the Winter Blea; they are ſhut by its contraction; and tho' a little water keeps them in that ſtate at theſe times of the year, the ocean could not at an ill ſeaſon open them. Even in freſh pieces of the Blea the very form of theſe veſſels is loſt, as ſoon as their juices leave them. Where-ever a piece is carefully and lightly torn off, the Microſcope ſhews its veſſels in their cylindric form at firſt; and ſomething of their mouths is viſible in the more perfect end of the piece; but where they have been broken, and their juices let out, they collapſe, and nothing but a kind of flat white thread is diſtinguiſhable. Fig. 3. *a b c.*

The

The Willow was ſelected to ſhew the uſe theſe veſſels have in the Vegetable Oeconomy; becauſe in that light and looſe wood the mouths are very diſtinguiſhable: but there are other kinds in which the general conſtruction is more evident: the Pear is one: in this firm wood the veſſels are much plainer, though their mouths are leſs; they differ alſo in colour from the intermediate matter; for they are browniſh, while that is pure white; and being firm they are leſs liable to contraction.

I cannot tell whether ſome eyes diſtinguiſh better by the Microſcope than others; whether the preciſe focus is leſs eaſily found by thoſe not ſo much accuſtomed to the Microſcope; or whether there be any other advantage which that great nurſe of aptneſs, Practice, gives; but to whatever it be owing, I have found it very difficult to ſhew ſometimes to others the things myſelf have ſeen moſt clearly: and I have named it in the preſent object becauſe it once afforded a remarkable inſtance.

The

The Blea of the freſh Willow appeared to a very careful obſerver all one ſubſtance; the mouths in the veſſels were ſeen, but not the diſtinction of veſſels and Flock. But a piece of the freſh Blea of Pear Tree then was placed in view, and while we looked at it, the natural contraction from the evaporation and loſs of the fluid contained in it, began; and the floccoſe matter ſhrank ſo much faſter than the veſſels could, that though the ends had been cut even at firſt, they were ſoon ſo altered that the veſſels ſtood out far beyond the Flock, and ſhewed their form and ſeparate nature moſt diſtinctly.

In the Ozier, taken in its ſeaſon of quickeſt growth, in Spring, the Blea affords theſe veſſels yet more diſtinctly even than the Willow; but the matter is more difficultly managed; for they are ſo tender, ſo ſoft, ſo watery, that 'tis ſcarce poſſible to keep them together. Fig. 5. ſhews a piece of it; in which appears this farther diſcovery than had been made before, that the mouths of the Blea veſſels all open upwards.

In a piece yet farther magnified by a combination of two of the moſt powerful object glaſſes, and with the advantage of a room conſtructed purpoſely for this ſervice, a degree of light was made to penetrate the very ſubſtance of theſe veſſels. The firſt appearance it exhibited was that of many Cells or Blebs, ſuch as we have ſeen in the Bark and Rind; but on more obſervation the appearance of theſe Cells was found to be neither equal nor regular: Nature has nothing to do with ſo wild conſtructions as ſeemed to ſhew themſelves here: the truth was at length diſcovered: theſe ſeeming diviſions altered their places; and were found only to be ſmall portions of a watery Sap, which the contraction of the part had prevented from eſcaping with the reſt, at the mouths of the veſſels. This appearance is given at Fig. 6. and may be a very neceſſary leſſon againſt haſty judgments.

A Veſſel ſeparated from this Ozier Blea is ſhewn by itſelf at Fig. 7. 'Tis ſtrange that the coat of veſſels ſo tender ſhould be ſo thick in proportion to their cavity; but this is the leaſt compact of all Blea veſſels.

CHAP.

CHAP. VII.

Of the WOOD.

AS we proceed into the more inward part of the Shoot, in whatſoever Tree, the conſtruction becomes more difficult of obſervation: the parts are harder, and leſs free to ſeparate one from the other; but with due care theſe macerations will afford, from one kind of tree or other, pieces which will diſcloſe their inmoſt ſtructure. Many muſt be examined to find ſuch; for it is not always in the Shoots even of the ſame ſpecies theſe happy objects may be found; the different forwardneſs of the ſeaſon, the greater or leſs progreſs of the Sap, and even the more or leſs healthy ſtate of the particular Tree, all afford variations, and render the beſt ſometimes inferior to thoſe naturally much below them.

The common Pear Tree has afforded the inſtance from which the preſent views are given. A piece of the wood of this tree, clean, pure, and perfectly ſeparated from other ſubſtances, is ſhewn at Plate VIII. Fig. 1. nothing can be ſo ſimple as its ſtructure: tho' difficult to obtain, there is little for obſervation in it when we have it; only that truth is always valuable: and when we know the compoſition of the wood in one tree, we can underſtand it in all.

The Wood then is ſcarce any thing more than an arrangement of plain and ſimple tubes, reſembling the tubes of the Blea; but that there are no mouths in them; nor is there any of the interſtitial floccoſe matter between them more than what fills the very ſmall vacancies left by the roundneſs, between tube and tube: nay, even that diſappears as the wood grows harder; and finally, in ſome trees, even the tubes themſelves: their coats thickening both on the outſide and within, 'till neither cavity nor interſtice remains, but the whole is become one firm ſubſtance.

This

This may be ſeen in a tranſverſe view of the common Oak; ſuch being choſen as has grown on clay; for that from gravelly ſoils is much leſs compact, leſs weighty, and of much leſs ſtrength and value.

In the Pear, and in moſt other Trees, ſo much of the vaſcular appearance remains in the Wood, as always to make it eaſy to underſtand the ſtructure: we always ſee veſſels, tho' with ſmall apertures, arranged in lines the one behind the other, in many ſeries; adhering firmly, and leaving ſcarce any interſtices.

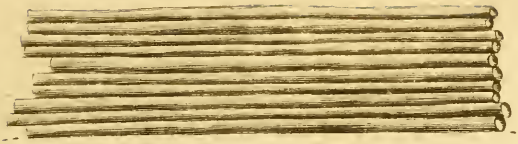
When a piece of freſh Blea is torn from a Shoot, we have obſerved that at the ragged end, where the veſſels have been broken off, they loſe their form; collapſing, and no longer appearing any thing more than flat threads: but 'tis not ſo with the more firm and ſolid veſſels which compoſe the Wood: they ſeparate indeed in a piece torn thin, but they keep their form and roundneſs, and break all together; not one by one; nor forming a kind of pyramid, as in the Blea; but an equal, even termination. A

piece of the freſh Wood in this view is given at Plate VIII. Fig. 2.

At Fig. 3. is the repreſentation of a piece of the wood of the Bauhinia Aculeata, whoſe difference appears very ſtriking; but 'tis merely that of greater and leſs: the veſſels in this are extremely ſmall, very hard, and laid unuſually cloſe together. The whole viewed with the uſual powers of magnifying appears one compact, uniform maſs; but greater glaſſes ſhew it formed juſt as the others; only that there is ſo very little of the interſtitial ſubſtance, that even in the youngeſt pieces the veſſels ſeem to fill the whole ſpaces, by ſwelling into them.

At Fig. 4. is repreſented a ſingle veſſel of the wood of the Pear, clean ſeparated from the other parts: this may be viewed all round, and thence we are confirmed the wood veſſels are mere cloſe canals, with no lateral apertures. The plain and ſimple hollow is alſo very well ſeen in theſe ſingle veſſels. Art would in vain attempt to procure ſuch: they are too ſmall to be the objects either of the hands or eyes; but there never fail to offer ſome of them among the variety

Wood



1 1

3

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4

5

6

variety of macerations; especially of such as have been rubbed about often with the hands.

At 5. is a section taken transversely from the bottom of Fig. 2. and at 6. a view of the like kind from the Bauhinia, Fig. 3. In the first we see a little remain of a spungy substance between the vessels: at 6. there scarce is any.

CHAP. VIII.

Of the CORONA.

'TIS strange that among all who have written on the construction of Trees and Plants, the Circle which surrounds the Pith, and separates it from the Wood, altho' different in a high degree from both, and of a composition not at all resembling either, should yet have had no notice, and no name. It is indeed

the moſt important part in the whole vegetable fabric; for 'tis from this alone propagation and encreaſe by Branches, Buds, and Shoots, is carried on.

It has been a cuſtom to ſuppoſe the Pith of Vegetables to be the part in which theſe wonderful ſources of increaſe reſide: but this theory ſhrinks to nothing before a careful enquiry. The ſtate of the Pith in young Branches will be ſhewn in a ſucceeding part of this Treatiſe; and it will be found diſcontinuous from the original Pith of the Trunk; and ſo far from proceeding from it before the other parts, that it is in reality poſterior to ſome of them in the time of its formation. This important office of encreaſe being given to the part to which it belongs, we ſhall ſee that the Corona is in every ſenſe, both of conſtruction and uſe, an object very worthy of a careful examination.

We have hitherto been employed about parts of Plants which are perfectly uniform in their conſtruction. Nothing can be more ſimple than the compoſition of Wood; and if in the Blea and in the Rind there be a more elaborate

ſtructure,

ſtructure, ſtill it is the ſame in all the Blea; and in the Blea of all Trees. Here we have a matter perfectly different; the Corona is not uniform, but conſiſts of a variety of parts: nor is their nature or their diſpoſition the ſame in all Trees. It is not ſtrange this Circle ſhould ſo differ from the others; for they form and conſtitute only one part of the Shoot; but in this lie the rudiments of the whole: and the Branch which is to contain all thoſe parts, is to receive them only from this Circle.

The Corona then is a ring uſually more or leſs angulated in its out-line, placed between the Wood and the Pith in all Vegetables. The general Circle is cellular, compoſed of Blebs and veſſels, as the Bark and Rind, and is perfectly of their nature; only that at different diſtances are diſpoſed among it oblong cluſters of different veſſels. Theſe cluſters are uſually eight or ten in number; and give origin to the angles of the Corona. They are not uniform or of one kind of veſſels, as in thoſe in the Bark, but each has two diſtinct ſorts; the exterior ones anſwering to the Blea, and the interior to the Wood of Trees: and within each of theſe are alſo diſ-

poſed

poſed veſſels not unlike thoſe in the Blea and Wood, and often even larger than they are found in thoſe parts in the Shoot.

Thus we ſee that each cluſter of the Corona is compoſed of all the eſſential parts of the ſucceeding Branch, and that the intermediate parts of the circle are abſolute Bark and Rind: they are ready to follow and cloath the cluſter when it goes off in the form of a Shoot; becauſe it will then need their covering and defence, tho' in its preſent incloſed ſtate it does not.

It is from this conſtruction that a Tree is at all times, and in all parts, ready to ſhoot out Branches; and every Branch in the ſame manner to ſend out others: for the whole Trunk, and the Branch in all its length, have this courſe of eight or ten cluſters of eſſential veſſels ready to be protruded out; and the proper and natural integuments as ready to cover them.

In ſome trees theſe parts are more evident, in others more obſcurely arranged; but when their nature is known, there is none in which they may not be found.

The

The Oak is not one of thoſe trees in which they are moſt conſpicuous and diſtinct; yet will the moſt curſory obſerver perceive, in a tranſverſe ſection of a Shoot of that tree, that the circle immediately ſurrounding the Pith is perfectly diſtinct; both from the Pith which it encloſes; and from the Wood which ſurrounds it. A ſection of the Oak is given for this purpoſe at Plate IX. Fig. 1. and near it, at Fig. 2. is placed a ſection of that tree, in which, of all that I have had the opportunity of examining, this circle is the moſt diſtinct. This is the Parrot Wood of the Weſt-Indies, the Bocconia of Botanical writers. It ſeems formed to lay open this great myſtery of Nature; for nothing can be ſo palpable as the conſtruction: 'twere well if this ſpecies were always at hand in Europe; probably it will be ſoon: in the mean time, the only Vegetable wherein the parts can be ſeen in a manner any thing reſembling this, is an herbaceous Plant, the greater Celandine; to which indeed this Bocconia is in its Botanical characters, as well as in its inner ſtructure, very nearly allied.

This

This tranſverſe ſection of a Shoot of the Bocconia is given at Plate IX. Fig 2. With what ſuperior beauty muſt it appear from a freſh Branch: for this was from one brought from Jamaica, and rendered manageable to the knife by a long infuſion in water. We ſee here the Rind *a*, with its Bark underneath, *b*; and the Vaſa exteriora and interiora evidently mark'd in them. Beneath theſe, at *e*, lies the Blea, perfectly diſtinguiſhable from them, but ſcarce at all from the Wood, *f*, the Branch being very young and tender. But even in this ſtate the part immediately within the Wood is moſt palpably diſtinct: its ſubſtance, ſtructure, colour, every thing, ſhew that it is neither of the nature of the Wood, nor of the Pith: equally unlike both: and within this, but extending each way beyond it, are thoſe cluſters of veſſels which we find in all Coronæ, tho' leſs diſtinct: theſe intrench upon the Pith one way, and upon the Wood itſelf another; being in their nature and office of much more importance than both. At *b* is ſhewn the ſubſtance of the Ring or Circle, the immediate matter of the Corona; and at *i i* the cluſters of veſſels which at their

egreſs

egreſs from the tree are to form Branches: thoſe the matter of the Corona always follows out, in quantity enough to cloath them.

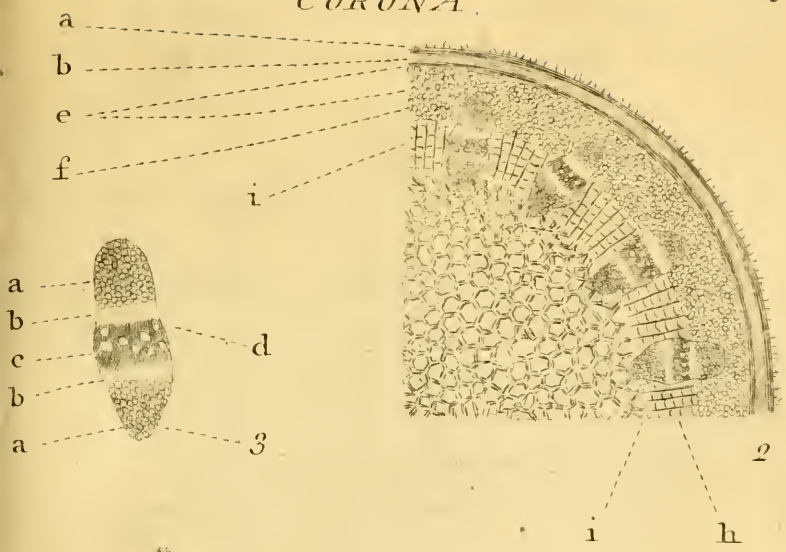
One Cluſter, ſeparated from the Ring, is repreſented more enlarged at Fig. 3. In this we palpably ſee the ſubſtance of the Blea and the Wood, and yet more evidently the veſſels of that latter part. At *a* the looſe and open texture of the Blea cannot be miſtaken by any who are at all accuſtomed to theſe obſervations: at *b* the cloſer ſtructure of the wood is perfectly diſcloſed: and at *c* a part of the ſame wood ſurrounding the great veſſels; but of a ſofter ſubſtance than the other, that it may not be capable of preſſing thoſe veſſels, on whoſe free courſe the growth of the whole Shoot, to ariſe from this cluſter, perfectly depends. At *d* the great veſſels themſelves are ſhewn, not at all exaggerated by fancy, or the rage of ſyſtem. It is juſt ſo they appear, and will always appear; even in the herbaceous Celandine; as well as in the arboreſcent Parrot-Wood.

At

At Fig. 4. is given alſo an enlarged view of the ſubſtance of the Corona; in which, as in all juſt opinions, the greater power we employ to examine, the more light is thrown upon the ſubject. If it had been poſſible before to doubt the nature of that circle; under this advantage of greater magnifying, it is not. The ſtructure of Rind and Bark are ſo diſtinct in it, that an accuſtomed eye would declare at once, that it was a view of thoſe two parts taken from ſome very good ſubject which he had before him: they would appear the abſolute Rind and Bark of a Shoot, not their embryo's in the Corona.

On the Corona and its Cluſters, (for in Nature they are never ſeparated,) on this complex part depends that incommunicable property of Vegetables, that they can be produced entire from every piece. In animals, even where bounteous Nature has given the wonderful advantage of a re-production of parts, ſtill it is but the part which was loſt that can be ſo produced. The leg of a crab being broken off, a new one grows in its place: but then it is only a leg. Nay, even in Spalanzani's great experiment of the jaw of

CORONA.



of the Newt, when that part is cut away, 'tis that part and no more that grows again: but in Vegetables the whole ariſes from a part; and that from every part cut off tranſverſely, with almoſt equal eaſe.

Theſe Cluſters follow the courſe of the other portions of the Tree; they are therefore every where: they are always capable of growing; and their growth, even in a cutting of the ſmalleſt twig, cannot produce a leaf or any other part of a vegetable alone, but muſt afford the whole; for they are complete bodies, and the whole is there, waiting only for the means of extenſion, ſufficient nouriſhment.

'Tis hence in all trees Shoots are thruſt forward from the Crowns and ſides of Branches in Spring, and after Midſummer, the ſeaſons when the veſſels are moſt filled; and hence that at all ſeaſons, under ſufficient ſhelter and defence, Branches riſe from naked cuttings, under the Gardener's care. That they do not riſe with equal eaſe and readineſs from all kinds of trees is owing merely to the difference of conſtruction in theſe Cluſters of the Corona. In thoſe ſpecies where that

ſpungy

ſpungy matter of the wood, *d*, Fig. 3. is very looſe and open, the cuttings grow very freely: in thoſe where the ſame ſubſtance is much more compact, and preſſes more upon the veſſels, they grow more difficultly; and where it is very hard, they will not in the common method grow at all. It will be worth the practical Gardener's while to attend to this: for, to raiſe ſuch trees from cuttings, there requires only to wound in many places this interior woody ſubſtance, and that way, to give the veſſels freedom. He muſt not be expected to uſe Microſcopes to find them out, 'tis ſufficient that he be told in general where they are; they lie deep, juſt above the Pith: and when he would raiſe a Tree or Shrub of the harder kinds from cuttings, he is only to cut into the piece all round, as ſurgeons ſcarify. He will deſtroy many of the parts; but enough will remain to furniſh matter for ſome Shoots.

Something of this truth ſeems to have been conceived by practical Gardeners; ſome of whom have recommended ſlitting, ſlaſhing, or pricking holes in the part of a cutting or ſlip to be put into the ground. Others have decried the practice;

practice; and, as they say, from ill success upon the trial. Both may write truly: but they have judged too generally on a subject where the matter depends upon the different structure of particulars. He that cuts or pierces a soft species, where the part surrounding these vessels is loose and open, lets in destruction and rottenness to the whole: but he who performs the same operation upon kinds where it is hard and too compact, gives course to the natural powers and method of encrease. If these kinds be scarified, and the others secured by wax from the too free ingress of the moisture of the earth, few will fail.

CHAP. IX.

Of the PITH.

IN the center of every young Shoot of a Tree resides the Pith: greater in some, and less in others; but present in all. It is placed close within the Corona; the moistening of whose clusters, and giving moderate and regulated way

to their extenſion, is its great office: for the thing itſelf, and its deſtined uſes, have been miſtaken. It is ſuppoſed coeval with, or primordial to all the other parts; but it is indeed poſtnate, and comes after them in the order of time, as well as in its uſes. It is no other than a cellular ſubſtance, formed from the inner ſurface of the Corona, when the growth of the cluſters of that part begins. We ſee nothing of it in the Corona itſelf, tho' ever ſo carefully examined; for it does not exiſt in that part while dormant: but as ſoon as a cluſter leaves the circle, and its parts ſeparate for growth, this ſpungy matter is formed within them. Exhaled air gives origin to its Blebs, while the thickneſs of the juices, cloathing the Bubble, gives it form and ſubſtance.

Thus is this interior ſubſtance formed, which has been ſuppoſed primœval, and the great cauſe of production, of all the reſt. Its office is required only while theſe cluſters take their firſt growth, and it acts no longer. The firſt ſeaſon is the time of its great uſe, and it immediately after begins to decay.

Thus

Thus we ſee trees have parts of limited and temporary uſe. The great veſſels of the wood perform their office for ſeveral years; but it is only at particular ſtated ſeaſons: in Spring and at Midſummer we find them in their duty, full of their proper fluid; at other times vacant and inactive: the Pith, in the ſame manner, lives and acts for the firſt year; and ſcarce longer.

The ſtructure of the Pith has been as little underſtood as its office: figures have been publiſhed of it, repreſenting it as formed in circles, hexagons, and polygons, with ſtarry points, and double lines, and an infinity more of various configuration: yet the thing is but one. To ſee it truly, we muſt look where it is moſt ſimple. The Walnut affords it in this condition. If we ſplit a Shoot of the common Walnut, of the growth of one ſeaſon, directly down the middle, we ſee the central part divided acroſs into ſeveral cells by thin membranes, as in Plate X. Fig. 1. 2. Each of theſe cells is oblong, ſmalleſt at the ends, and larger in the middle, as Fig. 1. *a.* and examining the ſmaller part we very diſtinctly ſee two membranes forming the two ſides of

the cell, and ſeparate from the membranes of the cells above and below, tho' they join the one and the other in the middle *b*. Following the courſe of this ſurrounding membrane round the whole of any one cell, we ſee that cell in its true nature: it is an oval Bladder or Bleb, of which this membrane forms the oval. Such a one is repreſented alone at Fig. 3. The whole of the Pith is the ſame with its parts; therefore the Pith of the Walnut conſiſts only of one range of theſe bladders, ſmaller at the edges, largeſt in the middle, and laid very exactly one upon another. The Corona of the Shoot keeps them in their place ſideways: they have no weight, ſo they do not preſs upon one another downward; and therefore they retain this form.

It is only in a very few trees that the Pith is of this ſimple conſtruction; but having ſeen it thus in one, we ſhall underſtand it in all. It is the quality of the Corona to throw out bladders of air, cloſed in thin membranes; they are large in the Walnut, and therefore each reaches acroſs the whole branch; but in other trees they are ſmall; and many of them muſt be laid horizontally together to extend from ſide to ſide

ſide of the Shoot. In the Dog-Roſe, repreſented at Fig. 5. we ſee it takes ten or twelve circles of the Pith Blebs, to fill the vacant middle of the Branch: but ſtill theſe Blebs are the ſame as in the Walnut; only that here they are ſmall and round; in that large and oval.

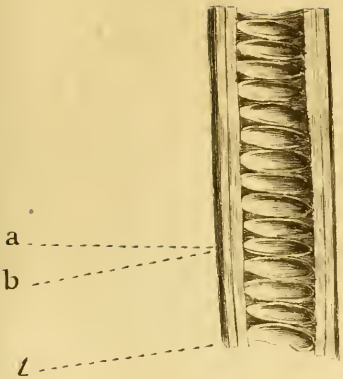
One of theſe Blebs, ſeparated from thoſe above, below, and on each ſide of it, appears as at Fig. 6.

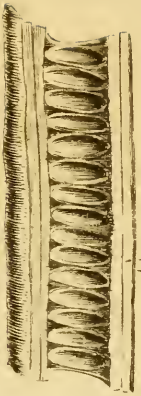
It will be obſerved that at Fig. 5. where the whole body of the Pith is repreſented together, the outline of every Bleb appears double; and, as it were, jointed in ſeveral places. This is one of thoſe wonders which have been repreſented in elaborate engravings: but it is the mere deception of the eye, viewing a thickneſs of the Pith in which a great many beds of the Blebs are ſeen together, lying over one another. There is no difference in the form of one Bleb and another; and we have ſeen at Fig. 6. what one Bleb is. Its membrane is ſimple, and its outline is ſingle; but here the outlines of many Blebs are ſeen one over another, and variouſly interſecting one the other.

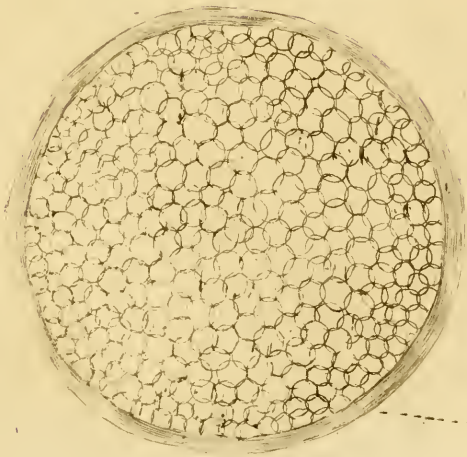
It has been the cuſtom to view ſuch a ſlice of the Pith as could be cut off thin with a razor; but the moſt careful way of executing this takes in many courſes of theſe Blebs. In a ſlice cut to one thouſandth part of an inch, by the engine here figured, a great part of this deception vaniſhes, becauſe very few beds of the Blebs are taken: and in one of the fifteen hundredth part of an inch, (for the inſtrument will afford ſuch) the whole error vaniſhes. We ſee the thing as it is; one ſimple arrangement of cut Blebs. Such a piece is repreſented at Fig. 7.

With reſpect of thoſe other figures ſuppoſed to exiſt in the Pith of Trees and Plants, I have ſometimes exemplified their appearance by the ſtructure of a piece of gauze; which, tho' compoſed only of ſtrait lines, perpendicular and horizontal; that is, forming ſimple ſquares; yet if it be laid double, a new arrangement of lines appears; and if again doubled, yet another; and ſo on, till, at ſix times doubled, the variety is in a manner endleſs. The difference of figures cannot be more between the appearances of the Pith of different trees, all

PITH







made by ſimple circles, than in theſe which ourſelves have formed of ſimple ſquares.

Thus ends the examination of the ſeveral conſtituent parts of Timber. Theſe are all: They are eſſential; for they are found in all kinds; and they are here repreſented as they have appeared, in repeated obſervations, to the Author; to his noble Patron; and to many aſſemblies of philoſophic friends. Nothing is enlarged, nothing altered from what the ſight received in thoſe ſeveral views: if in any part he has been yet deceived, let it not be imputed to purpoſed miſrepreſentation. Nothing is feigned: and if in any thing he has erred; Reader! thou art a man, and pardon human frailty.

BOOK II.

Of the VESSELS of TREES.

CHAP. I.

Of the VASA PROPRIA EXTERIORA: or, The Outer Range of peculiar VESSELS in TREES.

THE Vaſa propria, or peculiar Veſſels in Trees, are not of the nature or condition of their conſtituent parts, already deſcribed. Theſe laſt are eſſential to the nature of a Tree, as a Tree: the others are accidental, and belong only to the ſpecies. The Vegetable Structure can exiſt without theſe: but it cannot without the others. They contain the particular juices

on

on which the virtues, qualities, and ſpecific properties of Trees depend. A Tree can grow and live, and give ſhade without them; but it cannot have eminent qualities. Thoſe are greateſt where theſe Vaſa propria are largeſt or moſt numerous: and where we ſcarce ſee theſe, we hardly taſte or ſmell the other.

Of theſe Veſſels there are many ranges diſpoſed in or between the ſeveral parts: their ſituation could not be underſtood from deſcription, until thoſe parts were particularly known; but now they will be traced with eaſe.

Of the Vaſa propria there are four kinds; and of theſe each has its allotted place, its peculiar form, its different ſtructure, and its ſeparate uſe. Some trees have them in all their parts; others in ſome of them; and there are which ſhew them not at all. Where they are not diſcernible by the eye, reference is to be had to the taſte; for if there be nothing perceived by that, where none appear to the ſight, it may be reaſonable to give over the ſearch, and conclude there are none.

To follow the order of their arrangement in the Tree, their kinds are theſe; 1. The Vaſa exteriora, lodged between the Rind and the Bark. 2. The Vaſa interiora, ſituated in the Bark. 3. The Vaſa intima, lodged in the Blea. 4. The Vaſa peculiaria, in the Corona. Beſide theſe, there are the Sap Veſſels in the Wood; but they are common to all Trees.

The firſt of theſe, the Vaſa propria exteriora, have been ſhewn in their place and proportion at Fig. 3. where they appear as round dark-coloured bodies, lodged between the Rind *a*, and the Bark *b*, and entrenching upon the ſubſtance of both, making their own beds half within the Bark, and half within the Rind.

To know their ſtructure we muſt carefully ſeparate the outer Rind from the inner Bark; and this may be done, with ſome attention, in a living Branch, juſt at the time of its ſwelling for the Spring, or for the Midſummer Shoot; but much eaſier by the means of maceration.

When

When the Rind is perfectly ſeparated that way, it leaves the Vaſa propria of this claſs behind it: they ſcarce adhere to the inner Bark; not at all to the Rind; and therefore lie undiſturbed upon the piece thus ſtripped. We ſee them as repreſented in Plate XI. at Fig. 1. they are diſpoſed in little packets, like cords, and do not run ſtrait down the Branch; but interweaving with one another, form a very pretty kind of net.

When we raiſe any one or more of theſe packets of Veſſels, we perceive that it here and there ſticks a little to the ſubſtance of the Bark, but no where to the other veſſels: they part very freely where they paſs over one another, and will indeed fall aſunder in thoſe places, if they be clipped ſhort, and ſhook about in a paper.

When we examine a thin tranſverſe piece of one of theſe packets, we perceive that it is compoſed of twelve or fifteen diſtinct veſſels, whoſe Rinds ſeem hard, and muſt indeed be ſo; for they preſerve their roundneſs notwithſtanding their

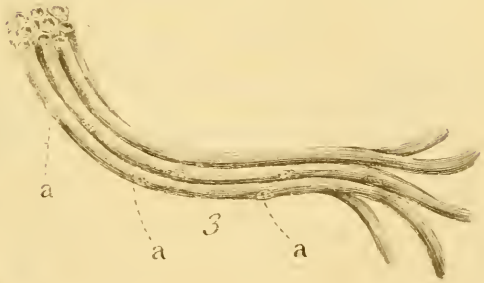
their mutual preſſure of one another, and the preſſure alſo of the Rind and Bark. A view of ſuch a piece is given at Fig. 2.

Laying ſeveral longer pieces of theſe packets before the Microſcope, we ſhall, with a great power, find ſome happy fragment in which we may ſee the cauſe and nature of the adheſion of theſe parts to the Bark. Such a view is given at Fig. 3. We ſee at one end the veſſels of the packet a little ſeparated, and in the parts *a a a* we perceive upon the ſides oval depreſſions, dotted as it were with pin holes; theſe are moſt probably a kind of glands, which ſeparate, from that general ſtore of Sap with which the Bark is filled, the peculiar juices which are found in theſe veſſels.

A great deal of patience, a vaſt number of objects, a good Microſcope, and a fair day are requiſite for viewing the Vaſa exteriora, for this purpoſe; but he who takes all theſe precautions will not be diſappointed.

If ſome of theſe packets be worked about with gentleneſs, the open ends will give an opportunity

VASA PROPRIA EXTERIORA



opportunity of getting ſome veſſels ſeparate and ſingle. Theſe being put into ſpirit of turpentine, will, after a week's ſtanding, become very tranſparent: and one of them, viewed with a great power, appears as at Fig. 4. divided in a very wonderful manner tranſverſely into cells: theſe are ſhort, oval, and terminated by hollow valves; and uſually, ſome of them being full, and others empty, the conſtruction is very prettily ſhewn. We ſee at *b b* ſome parts of thoſe pin hole glands; and it is ſingular they always have their origin at the baſe of a cell longer than the others. The brownneſs of the concreted juice in the Oak, from which all theſe obſervations are taken, renders the cells which are filled very diſtinguiſhable: but there are other veſſels, with colours more diſtinguiſhable ſtill, to be mentioned in the ſucceeding chapters.

CHAP.

CHAP. II.

Of the VASA PROPRIA INTERIORA.

THESE are Veſſels generally of more importance than the preceding; and often of more than any other part of the Tree. They are, in ſuch kinds as are renowned for medicinal virtues, uſually large: they carry the milk juices in the Sumach; and the greateſt quantity of the turpentine, as alſo the fineſt and higheſt flavoured, is lodged in them, in all the kinds of Pine. Their ſituation is ſhewn in the Oak in Plate III. at letter *d*; but tho' they are of no moderate ſize in that Tree, they are yet much larger in the Pines; we ſhould therefore ſelect a Tree of that genus for the tracing them in the preſent inſtanece, if there were no other cauſe of preference: but 'tis our buſineſs to ſee them

them as clear and free from their juices as poſſible, in order to underſtand their ſtructure; and happily the juice which fills them in the Pines, being a pure turpentine, is capable of a perfect ſolution in ſpirit of wine.

The ſpecies of Pine in which theſe Veſſels are ſeen moſt of all diſtinctly, is the Pinus Orientalis of the Botanical Writers. They are vaſt apertures in every kind of Pine. If we view them juſt cut we ſee bubbles of a yellow turpentine riſing out of them. If a thin tranſverſe ſlice is laid before the Microſcope, after ſoaking it in ſpirit of wine, they appear as great oval holes, into which ſtraws might be thruſt without doing them violence. Such a ſection of the Oriental Pine is given at Plate XII. Fig. 1. where we ſee a chain of theſe vaſt apertures regularly placed in the ſubſtance of the inner Rind, and conforming themſelves to the ſhape of the Branch.

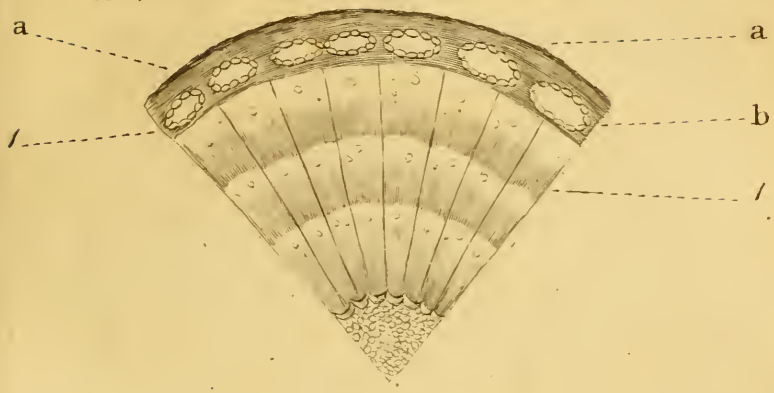
It cannot but be obſerved, even by the leaſt curious, that the outline of theſe veſſels is compoſed of a Ring of oval apertures, *b*: theſe are in reality the mouths of other veſſels; and the

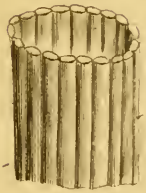
reſult

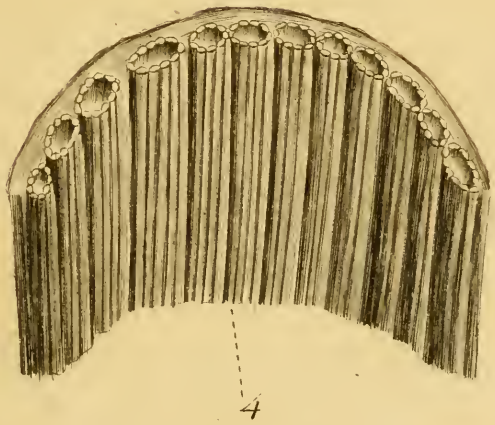
reſult of the obſervation is, that the very coats of theſe veſſels are themſelves vaſcular. A view of an arrangement of theſe veſſels, as they appear in a tranſverſe Slice cut from one of the Vaſa propria of this Pine, is given at Fig. 2. They appear, by the ſtricteſt enquiry I have been able to make, to be of the ſame nature with thoſe which conſtitute the Packets in the Vaſa propria exteriora; ſo that if we conceive one of thoſe Packets opened in its center, and the veſſels driven every way outward till they are ſtopped by the ſubſtance of the Bark, they will give us an idea of the ſtructure of the Vas interior, which is no more than a great cylindric hollow formed in the center of ſuch a Packet. A view of ſuch a veſſel, as taken out of the Pine, is given at Fig. 3. and at Fig. 4. is repreſented their exact diſpoſition in a ſomewhat older Branch, where the hardening of the parts has driven them cloſer together; and where they appear as in the hollow of ſuch a piece; the Wood Blea, and even part of the Bark, being pulled away. Few Trees afford more beautiful objects than a piece like this, of the Pine, before the Microſcope here deſcribed, uſed in the oblique manner.

From

VASA PROPRIA INTERIORA







From what we have ſeen of the conſtruction and uſe of the Vaſa exteriora, the nature of the purpoſes theſe anſwer in the Vegetable Oeconomy is not hard to trace. If, as is moſt probable, the veſſels of the coats of theſe, are the ſame with thoſe, they are filled with the eſſential juices of the Rind; and from thoſe cells 'tis probable that they diſcharge the matter they contain into theſe great receptacles, thro' apertures in that part of their ſurface which forms the inſide of theſe veſſels: but this is no more than opinion. Conjecture muſt be carefully diſtinguiſhed from obſervation; and it muſt be owned it may err here: for theſe veſſels are ſo ſmall, and ſo difficult to be got at, that I have never been able to ſee either theſe openings, or their contents. But whether it be by theſe or by any other means the Vaſa interiora are ſupplied, their office is certain; they hold a rich juice, ſecreted from the nouriſhment of the plant, perfectly ſeparate from all the other fluids: and from their ſituation in the outer Bark, it is evident whence it happens that in this part we find the virtues and the flavours of Vegetables moſt reſide.

CHAP. III.

Of the VASA PROPRIA INTIMA.

NOtwithſtanding that there are in the conſtruction of a piece of Timber two arrangements of Veſſels within theſe Intima; namely, the great Sap Veſſels of the Wood, and thoſe of the Corona; yet as the former are not of the nature of Vaſa propria, (not carrying any peculiar juices, but only Sap, which is nearly the ſame in all Trees) and as the others are not of one kind, but a mixture of ſeveral; and indeed are only repetitions in miniature of theſe, and the preceding; the Reader will not diſpute the name Intima to the preſent.

They are large, conſpicuous, and very important veſſels: their natural place is in the Blea; the part of a Tree which lies between the Bark and the Wood: they are never ſeen in any place exterior to this, but ſometimes they are repeated in the very ſubſtance of the Wood; nay, and in the Corona itſelf; in ſome degree diſplacing and intercepting the other parts.

It is very eſſential to ſee theſe in a Tree where they are moſt conſpicuous: for their being thus intermingled among other parts, renders them in many inſtances obſcure: at leaſt the beſt obſerver will be able to find them much the more readily in other kinds, from having once ſeen them where they are thus obvious. Their coats are thicker than thoſe of any other veſſels; but in ſome kinds they have alſo a colour in their contents that renders all doubt concerning them impoſſible.

The Tree in which they appear moſt palpable of all, is the Piſcidia Erythrina. In this they have a ſcarlet colour, never to be overlooked:

and it happens that the other parts lie ſo conſpicuous and ſo regularly about them, that they muſt be known every where, for ever, by any one who has once ſeen them here. A view of a tranſverſe ſection, from the Shoot of this Tree, is given at Plate XIII. Fig. 1. In this the Vaſa propria interiora (*a*) hold a diſtinguiſhed place; and juſt within their circle lie the intima; large, ſingle, conſpicuous, (ſee the letter *b*) diſpoſed in a manner perfectly ſingular: certain aſſemblages of them, about three in number, following their exact courſe in the Blea, but alternately arranged in lines and triangles. Beſides theſe there appears here and there one of them looſe and unarranged among the Sap Veſſels of the Wood, as at *c*. And in the Corona there is ſeen at *d* a perfect circle of them, in the ſame alternate arrangement of lines and triangles.

The Reader will be pleaſed to obſerve, that in this and all the other figures of ſections given in this part of the Work, the Veſſels and other parts intended to be particularly ſhewn are the only finiſhed parts. The conſtruction of the reſt is thrown in faintly, that the eye may not be confuſed.

confuſed. There is more in the Piſcidia worthy of note beſide theſe Vaſa intima; and it will be figured again with that view hereafter.

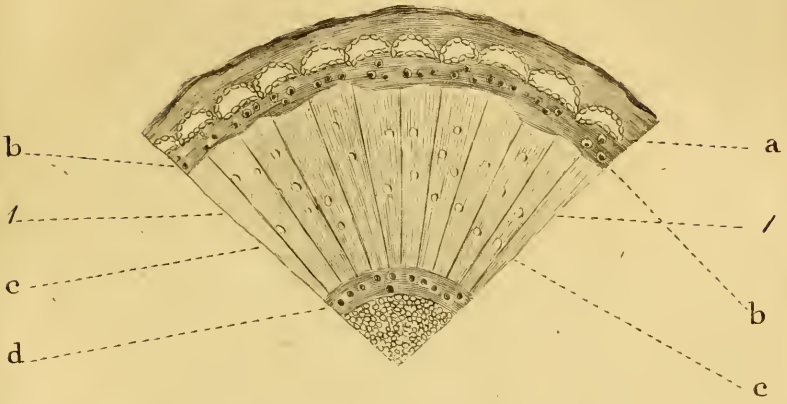
The exact ſituation of the Vaſa intima in this Tree is always ſubſervient to that of the Vaſa interiora: thoſe are placed near the inner edge of the Bark, and the intima keep a nearly exact diſtance between them and the Wood; three of them appear to accompany one of the interiora, as in Fig. 2.

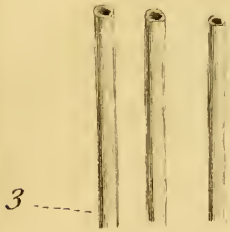
It is not at all difficult, after a ſucceſsful maceration, to ſeparate ſome of theſe veſſels from the Blea: in that ſtate they appear perfect cylinders, with thick white coats, filled with a hard red juice: and, ſo far as I have been able to ſee, perfectly uniform on their ſurface. Some of them, thus ſeparated, are ſhewn at Fig. 3. It is thus alone we can view them by the common powers and apparatus of Microſcopes; but 'tis not thus they are ſeen in their greateſt beauty—To obtain that, a piece of a young Branch of the Piſcidia is to be cut into ſhort cylinders; one of theſe is to be ſplit; and after

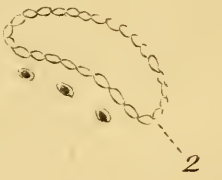
juſt ſo much maceration as will looſen the parts one from another, the Wood is to be got away. This is beſt done by means of a ſmall hollow chiſſel, ſhaped like the half of a quill. The opening is to be made with this, and then the Wood pulled away with a pair of fine pincers. The part where the chiſſel paſſed is to be cut off and thrown away, and the reſt preſerved for obſervation. Many pieces ſhould be treated in this way, and chiſſels of many ſizes uſed for this purpoſe; for 'tis only by that variety, and among a number of pieces, that one or two can be found happily cleared of the interior part. One of theſe pieces, ſucceſsfully cut, is repreſented at Fig. 4. And beſide the Vaſa interiora, which make a very pretty appearance in ſuch an object, we ſee theſe intima in every view we could wiſh: upon the top of the ſection we ſee their white mouths filled with a crimſon concreted juice; and upon the ſplit ſides we ſcarce ever fail to ſee ſeveral of them in their whole length; for their coats are ſo ſtrong, that they very ſeldom tear; but uſually ſtand out, in their places.

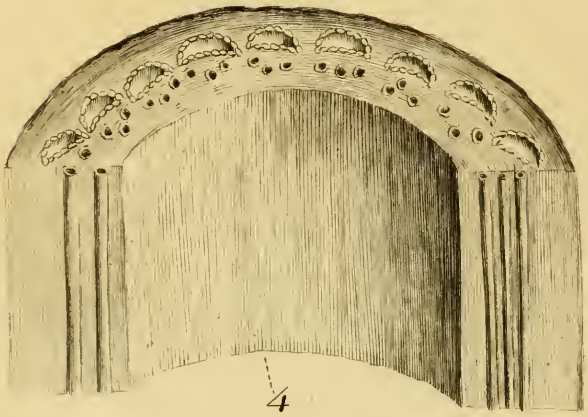
The

VASA PROPRIA INTIMA

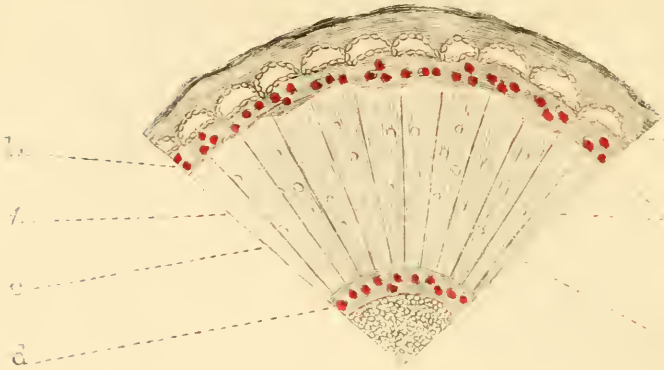


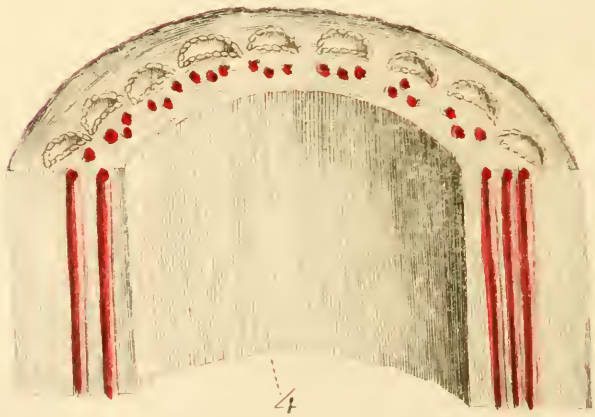






VASA PROPRIA INTIMA





The coat of the Vas intimum has nothing of that vaſcular ſtructure of that of the interius: it ſeems one firm, ſolid, uniform, woody ſubſtance, formed to keep the precious juice it contains in perfect ſecurity. It muſt not be omitted here, that this juice, in the preſent inſtance, is of a ſubſtance ſo compact when dry, and is ſo firmly united every way to the ſides of its veſſels, that preparations once made of the parts will never loſe their character. If a tranſverſe ſection be cut of only the thouſandth part of an inch in thickneſs, and be immediately plunged in ſpirit of wine, the Veſſels, when the whole is viewed in a few drops of the ſame ſpirit, appear as ſo many rubies: and ſo firmly does their contained juice keep its place, as well as colour, that many years ſteeping in the ſame ſpirit does not diſſolve, or ſeparate it. I would not venture to relate ſo ſtrange a thing, but that I have many Slices now in ſpirit which are unaltered in ſix years keeping. The matter of colour is ſo important in this object, that a ſecond Figure is given with that advantage. What this indiſſoluble juice is, (for neither does water affect it other-

wiſe than by deſtroying the parts in which it is lodged) or what may be its qualities, is a thing very worthy of trial. How great is the difference between this and the Turpentine of the Vaſa interiora, which the ſame ſpirit clears away with the greateſt eaſe!

CHAP. IV.

Of the SAP VESSELS.

IT cannot but have been obſerved, that in our IIId Plate, where all the parts of a Tree are ſhewn together, the moſt numerous, as well as the largeſt apertures, are in the Wood. All apertures ſeen by this view are the ends of veſſels cut thro' by the inſtrument; and the ſize and number of theſe command the firſt attention. They are in no Tree larger than in the Scarlet Oak of America. We have ſeen the appearance of

of a thin Slice in that Plate; but it will be proper to give here an idea of their diſpoſition in a ſplit truncheon of the ſame Tree; ſuch as the former. If a ſhort cylinder of a three years Branch of this Oak, a little macerated, be hollowed away with a chiſſel, ſo far as to take out the Pith and the Corona, it appears as at Plate XIV. Fig. 1. The Blea and Bark are there alſo puſhed away, ſo that the Wood forms almoſt the whole of the cylinder; and it is wonderful to obſerve how large a portion of it is occupied by theſe large apertures.

On the ſides of the ſplit piece we ſee theſe Veſſels very conſpicuous; for they are very thick: and it is not difficult, with ſome care and attention, to looſen ſeveral of them.

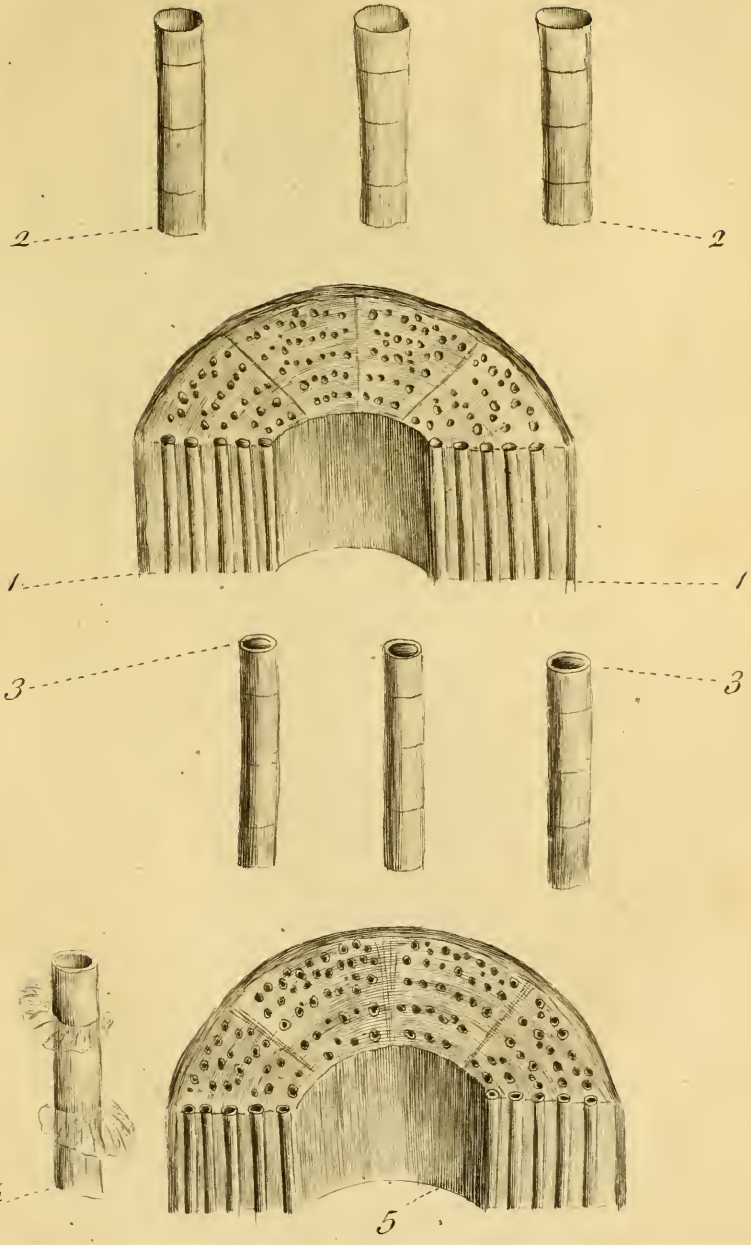
If a number of theſe, thus ſeparated, be put into a vial of rain water, and frequently ſhook for ſeveral days, ſome will at length be found perfectly clean. Theſe are to be then put into ſpirit of wine; and when that has been two or three times changed, they will be in a condition to be viewed for underſtanding their ſtructure.

Some

Some of theſe are repreſented, as they appear to a great power of the Microſcope, at Fig. 2. where, notwithſtanding all the violence that has been offered them, there will ſtill be ſeen in many of them the remains of valves; by which doubtleſs theſe Veſſels in a ſtate of nature are divided into many cells.

In the Willow-leaved Oak theſe Veſſels, tho' ſomewhat ſmaller, are firmer and more compact than in the Scarlet kind; and having thicker coats, are fitter for examination. In the Veſſels of the Scarlet Oak nothing could be ſeen under the name of a coat but a mere membrane, reſembling a piece of thin parchment. In theſe, as repreſented at Fig. 3. the coat is a palpable ring, in which traces of lines ſurrounding one another may be ſeen; by which 'tis not difficult to underſtand, that it is compoſed of ſeveral membranes covering one another. It has happened in ſome pieces of theſe Veſſels, long ſhook about in water, that the outer membrane has ſeparated itſelf like the hull of an almond in blanching; and in this ſtate we not only ſee that there is ſuch a membrane,

SAP VESSELLS



brane, or probably a number of ſuch membranes, but alſo that they are vaſcular, as at Fig. 4.

A ſplit and hollowed piece of the Willow Oak is repreſented at Fig. 5. in which the thick coats of theſe Veſſels render them very conſpicuous.

Theſe Veſſels, which are, in nature, ciſterns of Sap for the feeding the growth of the whole Tree; and from which it bleeds ſo freely in the Spring and at Midſummer; are ſo large that they are capable of being filled with coloured wax, in the manner of the veſſels in anatomical injections; and this way they afford ſo pleaſing objects for the Microſcope, and give ſuch excellent opportunities of tracing their courſe and ſtructure, that it would be invidious to conceal the method from the curious Reader.

A view of pieces of the Oak, thus treated, and of the effect it has upon their Veſſels, is given in the additional Plate XIV.

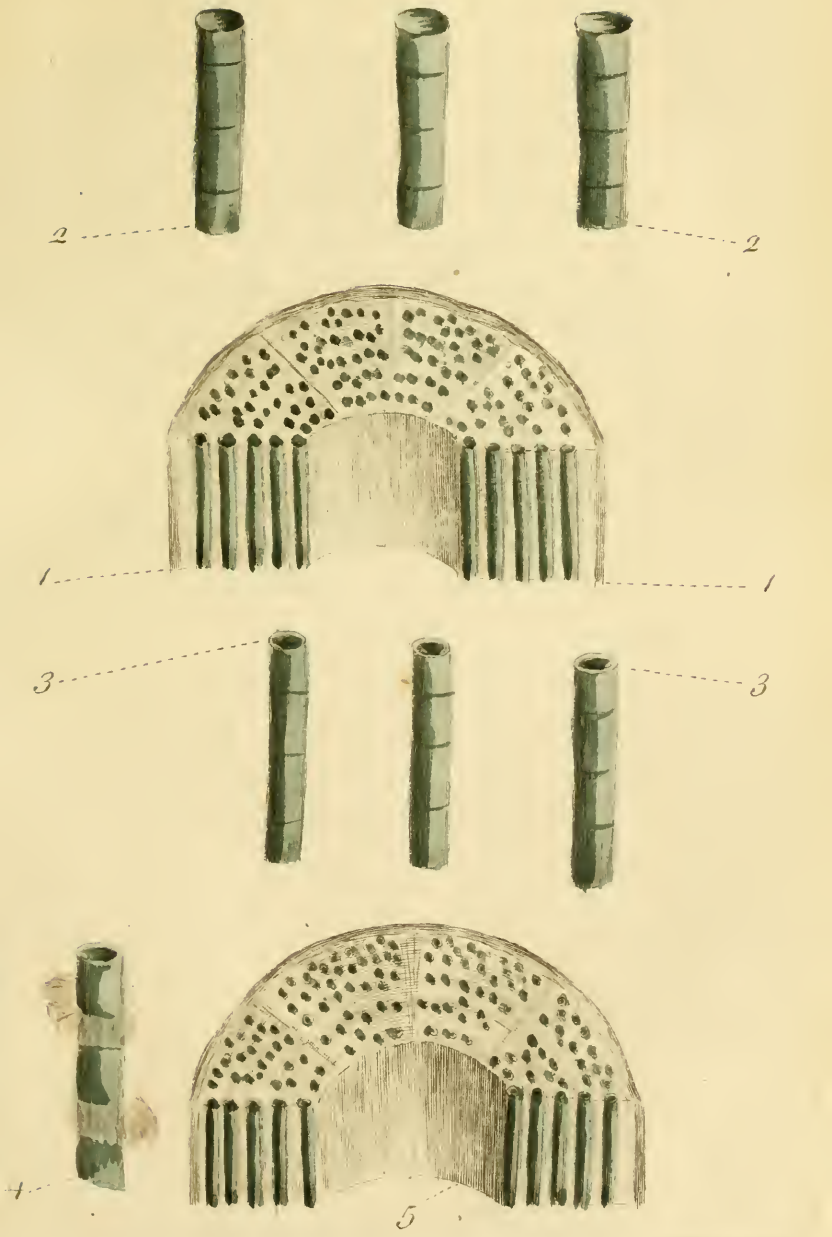
The

The method of filling the Veſſels is this:

A great many Shoots of the Scarlet and other Oaks are to be taken off in Spring; they muſt be cut into pieces of about two inches length, and immediately from the cutting they muſt drop into ſome warm rain water: in this they are to ſtand four and twenty hours; and then be boiled a little. When taken out they are to be tied on ſtrings, and hung up in a place where the air paſſes freely, but the ſun does not ſhine. When they are perfectly dry, a large quantity of green wax, ſuch as is uſed for the ſeals of law deeds, is to be gently melted in an earthen pipkin ſet in water, the water to be heated and kept boiling. As ſoon as the wax runs, the Sticks are to be put in; and they are frequently to be ſtirred about. They muſt be kept in this ſtate about an hour, and then the pipkin is to be taken out of the water, and ſet upon a naked fire; where it is to be kept, with the wax boiling, for two or three hours; freſh ſupplies of the ſame green wax being added from time to time.

After

SAP VESSELLS



After this it is to be removed from the fire, and the Sticks immediately taken out with a pair of nippers; when they are cold, the rough wax about them is to be broken off. Both ends of each Stick are to be cut off half an inch long, and thrown away; and the middle pieces ſaved. Theſe are then to be cut into ſmaller lengths, ſmoothed at the ends with a fine chiſſel, and many of them ſplit in various thickneſſes.

Thus are obtained preparations, not only of great uſe, but of a wonderful beauty. Many Trees this way afford handſome objects as well as the Oak; and in ſome, where the Sap Veſſels are few, large, and diſtinct, the ſplit pieces reſemble ſtriped ſatins, in a way ſcarce to be credited. It is in ſuch that the outer coats of theſe Veſſels are moſt happily of all to be examined.

CHAP.

CHAP. V.

Of the VESSELS of the CORONA.

WE have ſeen what are the differences of Veſſels in the Vegetable Structure; for we have already viewed all their kinds. The Corona is the whole in miniature: it contains the embryo's of future Shoots; and therefore muſt contain their Veſſels, and can contain no other.

We have ſeen that of the two parts whereof the Corona conſiſts, the Ring, and the Cluſters, the Ring is the ſame with the Bark; it therefore has the like Veſſels. Their appearance indeed is only that of the ſame objects viewed with a leſs power: only in one point there is a manifeſt

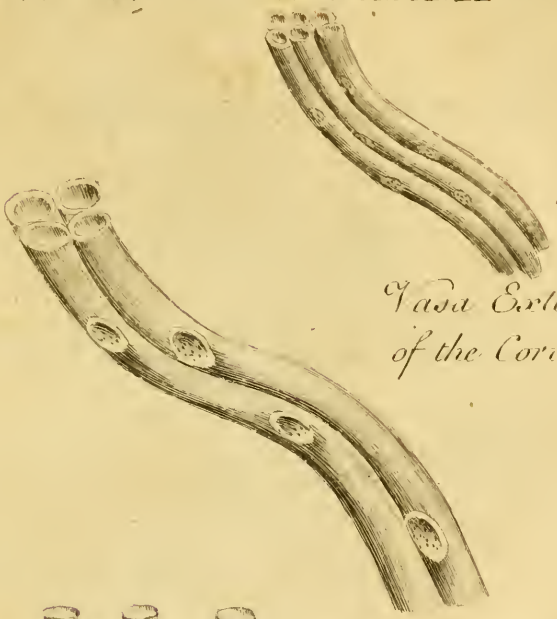
manifeſt diſtinction. This is in thoſe openings which a great magnifying power diſcovers in theſe Veſſels. Theſe are proportionably twice as big in the Bark Veſſels of the Corona, as in thoſe of the grown Branches: nor is it difficult, from what has been ſaid of their uſe, to gueſs the reaſon. Theſe Veſſels are repreſented at Plate XV. Fig. 1.

As the Veſſels of the Circle or Ring of the Corona differ in nothing eſſential from thoſe of the Bark; neither do the Veſſels of the Cluſters differ more from thoſe of the ſeveral parts of the grown Tree, of which they are the embryo's. It is often poſſible (I cannot indeed ſay it is always eaſy) to diſtinguiſh the Vaſa intima in the outer and inner ends of each Cluſter; among the Veſſels of the Blea. They, as well as the Blea Veſſels, are very difficultly viewed with any diſtinctneſs in this compact and crowded condition; wherein they ſtand in the Cluſter: but what difference I have been able to ſee, in theſe leſſer Blea Veſſels, is, that they have fewer but larger mouths than thoſe in the Blea of grown Shoots; and that there is an utter want of the ſpungy interſtitial matter which in that ſtate keeps them

ſeparate

ſeparate and at a diſtance. That the Vaſa intima, the proper object of enquiry here, have thinner coats, and are not ſo perfectly cylindric.

In the central part of every Cluſter we muſt expect to find thoſe vaſt Sap Veſſels which feed the whole interior part of the Tree; nor are we diſappointed: they are indeed yet larger in proportion here than we find them in the grown Branches; for 'tis here they have their greateſt uſe: 'tis theſe alone that can ſupply the Shoot in its firſt puſhing out from the Branch. It is to grow before it has communication with the outer air; and 'tis by theſe Veſſels, which here are always full, tho' in other parts they are ſo only at particular ſeaſons, that the growth of an angle of the Corona is to be ſupported and ſupplied in its egreſs into a Branch.



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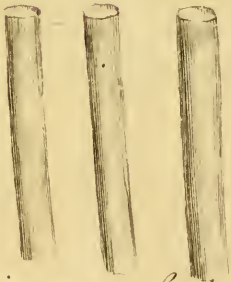
Vasa Exteriora of the Corona

Vasa Exteriora more Magnifyid



Vasa intema of the Corona

Sap Vessells of the Corona

BOOK III.

Of the ENCREASE by GROWTH.

CHAP. I.

Of the GROWTH of BRANCHES.

TO know the parts of the Vegetable Conſtruction, unleſs we have alſo from that knowledge learned ſomething of their uſes, were a vain and idle boaſt. The encreaſe of the Tree, the new and multiplied life that it receives from the growth of Branches, each capable of becoming an entire and ſeparate Tree by only ſticking it in the ground; is a matter of the firſt moment. The œconomy and encreaſe lie

here; and the uſes of men are ſupplied as well thus, as from ſeeds; and with the advantage of more expedition.

Since it is from an angle or part of the Corona the Branch naturally ariſes, 'tis in this place we may moſt naturally and uſefully trace it. There have been miſtakes about the nature and method of the growth of parts in Plants, as well as in relation to thoſe parts themſelves: but 'tis not the purpoſe here to point out the errors of others, but plainly to enquire the way to truth. It has been thought, nay it has been affirmed under the ſanction of very reputable names, that the Pith is the firſt part in all growth, and that the others form themſelves about to cloath it. Experiments have ſhewn 'tis otherwiſe; and the way to certainty in this enquiry is ſo plain, that 'tis impoſſible any one diſpoſed to obſervation can miſtake it.

The Pith is ſo far from being the original or firſt formed part, ſo far from giving origin to the reſt, that they are always formed or puſhed forth without it. The Pith begins to grow after the Branch has ſhot to ſome length, and ceaſes

ceaſes to be of uſe after a few months: nay in the end loſes again its accidental being, the Branch remaining perfectly ſound and healthy without it.

Any Cluſter in any part of the Corona, protruding itſelf onward and outward in the growing ſeaſon, carries a part of the Circle out with it. This protruſion is naturally made in the boſom of a leaf, becauſe the Bark and other parts are there weaker and moiſter. The Cluſter itſelf is a perfect piece of the Wood and Blea; and the Bark which follows it out in its progreſs, perfectly cloaths it. Thus is the firſt protruſion of the Shoot made: but all this while there is no Pith. There was none originally in the Cluſter of the Corona, and all things yet appear unaltered in it; only for their covering. The continuation of growth is made by the extenſion of all the parts obliquely upwards: in the courſe of this extenſion they hollow themſelves into a kind of cylinder, the form of the future Branch: and by this diſpoſition a ſmall vacancy is made in their center. This enlarges as they encreaſe; and as it enlarges it becomes filled by the exſudation of thoſe little bladders before-men-

tioned; which remain and conſtitute the Pith; fed from the inner coat of the wood, which already begins to form itſelf into a new Corona; by its elaſticity preſerving, and enlarging that cavity it fills.

To follow this enquiry ſucceſsfully, ſplit a young Shoot of the Red Dog-Wood, or of the common Dog-Wood of our hedges, early in Spring. If the fiſſure be continued directly thro' the two oppoſite Buds in any part, there will be ſeen an angle of the Corona forcing itſelf out on each ſide, in order to make a pair of oppoſite Branches. Each protruding angle forces its way thro' the ſoft young Wood, not by tearing its Veſſels, but gradually inſinuating itſelf between them; and nothing can be plainer than that it is an entire Cluſter which is thus thruſt forward to become a Branch; and that it leaves a thick line of the Circle or Ring of the Corona behind it. This is very happily viſible in the Red Dog-Wood of America; becauſe the Circle of the Corona is at that ſeaſon very green, and perfectly diſtinguiſhed from the Wood, which is of a whitiſh hue, and from the Pith, which is of a pale brown. The Bud, puſhing onward,

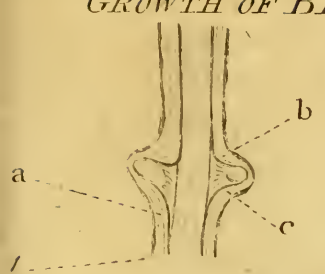
onward, leaves a kind of vacancy behind it, or between its aſcending baſe and the line of the Corona: thro' this vacant ſpace paſs a multitude of veſſels, which ſupply the aſcending Bud with a great deal of nouriſhment from the line of the Corona, which is left behind it.

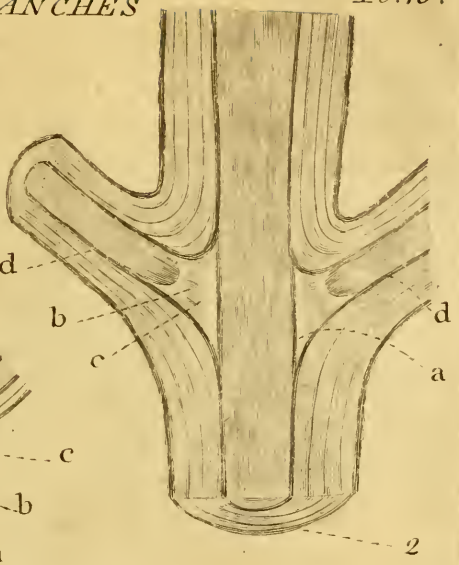
Here ſeems the great uſe of this line of the Corona in the œconomy of Nature: and in the path of knowledge it ſerves to eſtabliſh, beyond doubt, the True Hiſtory of the formation of that ſuppoſed original part, the Pith. The Cluſter of the Corona, which is to be a Branch, communicates with every part of the parent Tree; except its Pith; but all communication with that is ſtopped by this circle: nor can there be any intercourſe of juices between their Veſſels and its Blebs. We ſee in the examination of the Cluſter that it has no Pith of its own: we ſee by this line of the Corona it can have no communication with the Pith of the Tree; and 'tis not only impoſſible that this ſingular ſubſtance ſhould pierce that Ring, and enter the Cluſter, but our eyes ſhew a ſpace, a vacancy, between them: a part of the Shoot, wherein there is no Pith; and in its place a courſe of

Sap-Veſſels; things perfectly diſtinct from it, in nature, form, and diſpoſition. This ſpace, tho' it be proportionably greateſt in the very young Bud, yet it remains long viſible after the Branch is grown; nay, and in ſome kinds, does at length obtain a kind of coarſe Pith for itſelf.

At Plate XVI. Fig. 1. is ſhewn a piece of a young Shoot of Dog-Wood, ſplit thro' the two oppoſite Buds, to ſhew their nature. The part *a* is the remaining line of the Corona; *b* is the ſpace left by the aſcending Bud; and *c* are the Veſſels pervading it.

If now we take a thicker piece of the ſame Shrub, and inſtead of ſplitting it thro' two Buds we carry the knife thro' the ſtumps of two Branches, formed by two ſuch Buds in ſome preceding ſeaſon, we find the veſtiges of every part remain. Such a piece is repreſented at Plate XVI. Fig. 2. Here we ſee the line of the Corona (letter *a*) ſtill remain, but not ſupplied with any new Cluſter: and hence we may learn that a ſecond Branch can never riſe from the ſame ſpot, altho' the firſt ſhould periſh by any accident.


a
b
c
1


d
b
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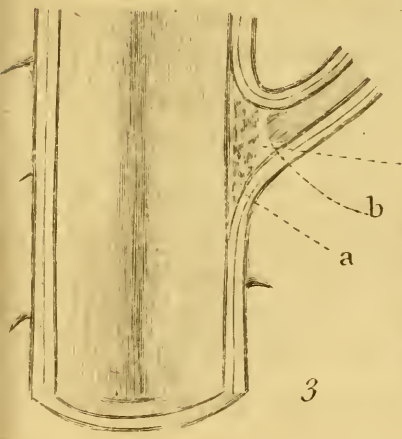
a
2


c
b
a
3

4

5

accident. At *b* the ſpace ſtill remains; and its Veſſels *c* run thro' it: but as we carry our eye along the aſcending Shoot, we ſee at *d* a Pith in all reſpects the ſame with that in the center of the parent Branch. This Pith of the Shoot is not continued from the Pith of the Branch, as has been ſuppoſed; for they are not, nor ever were, continuous: there is, there always has been from the beginning, a ſpace between them: the ſpace exiſted even before the Pith of the Shoot was formed. This Pith therefore was neither derived from the parent Tree, nor original in the Shoot; but is a mere temporary and periſhable production, exſudated from the Shoot itſelf, and deſtined to ſerve its preſent purpoſes, and then to periſh.

Let not the newneſs of this opinion make any one pauſe to receive it! Had we never had new opinions, old errors would have been immortal: but happily here we may refer not only to the Reaſon, but the Eyes! The ſhrub is before every one; a pen-knife makes the diviſion; and ſcarce a common reading-glaſs is neceſſary to obſerve it.

Altho' in this Shrub the vacant ſpace left by the aſcending Cluſter remains empty, it has been obſerved that there are ſome in which that very ſpace itſelf becomes, after a time, filled with a ſort of Pith. The Dog-Roſe or Wild-Briar of our hedges gives an inſtance; and it is always happieſt in theſe purſuits when the needful objects are the moſt familiar.

A Branch of this, with a Shoot riſing from it, is repreſented at Fig. 3. In this the line of the Corona left behind is very diſtinctly viſible at *a*; and the Pith of the Shoot at *b*; terminating, as is always the caſe, convexly towards the Branch. Theſe two parts are very diſtinctly known by their green and brown colour; and in the original vacancy at *c* there is found a maſs of a kind of Pith, very coarſe in compariſon of that either in the Branch or in the Shoot; and perfectly diſtinct from both, communicating with neither.

In the Virginia Creeper, Fig. 4. the very Pith of the Stem is not continuous; but ends obtuſely

tuſely upward, and obtuſely downward, as in the Branch. And in our own Vine it is not only diſcontinuous, but in the moſt perfect ſtate of the Tree is intercepted, as at Fig. 5.

CHAP. II.

Of the PROLONGATION of the SHOOT.

THE Prolongation of a Shoot already formed, is plainly a matter of more ſimple circumſtance than the production of a new one: and here one would ſuppoſe the Pith, like the other parts, might be found continuous: but Nature, always conſiſtent with herſelf, the God of Nature acting every where in the ſame amazing manner! confirms the doctrine of the ſeparate formation of that part, in the Shoots, by its appearance, leſs expected here.—Be it ſuffered, Lord! to uſe thy name in honouring thy works.

The

The Prolongation of the Shoot in Trees is not a thing conſtantly and regularly going on; it has its ſeaſons and its times; and takes its courſe more rapidly at ſome, more ſlowly at others: and there are ſome when it nearly ceaſes.

Let us follow its progreſs thro' a year; for the ſame is every year repeated: and tho' in various degrees of greater and of leſs, of ſwifter and of ſlower; it is the ſame in all.

In October, if we ſelect a Shoot of the Aſh-Maple, a quick growing Tree, we ſee its end terminated by a cone, compoſed of films. Here the growth of the paſt ſeaſon has ſtopped. This cone is what we call a Bud; and thro' theſe films, at the enſuing Spring, the Prolongation of the Shoot is to be continued. Such a piece is repreſented at Plate XVII. Fig. 1.

In this ſtate it remains thro' Winter: the cold having cloſed thoſe pores thro' which the Root uſed to draw in the greater part of its nouriſhment.

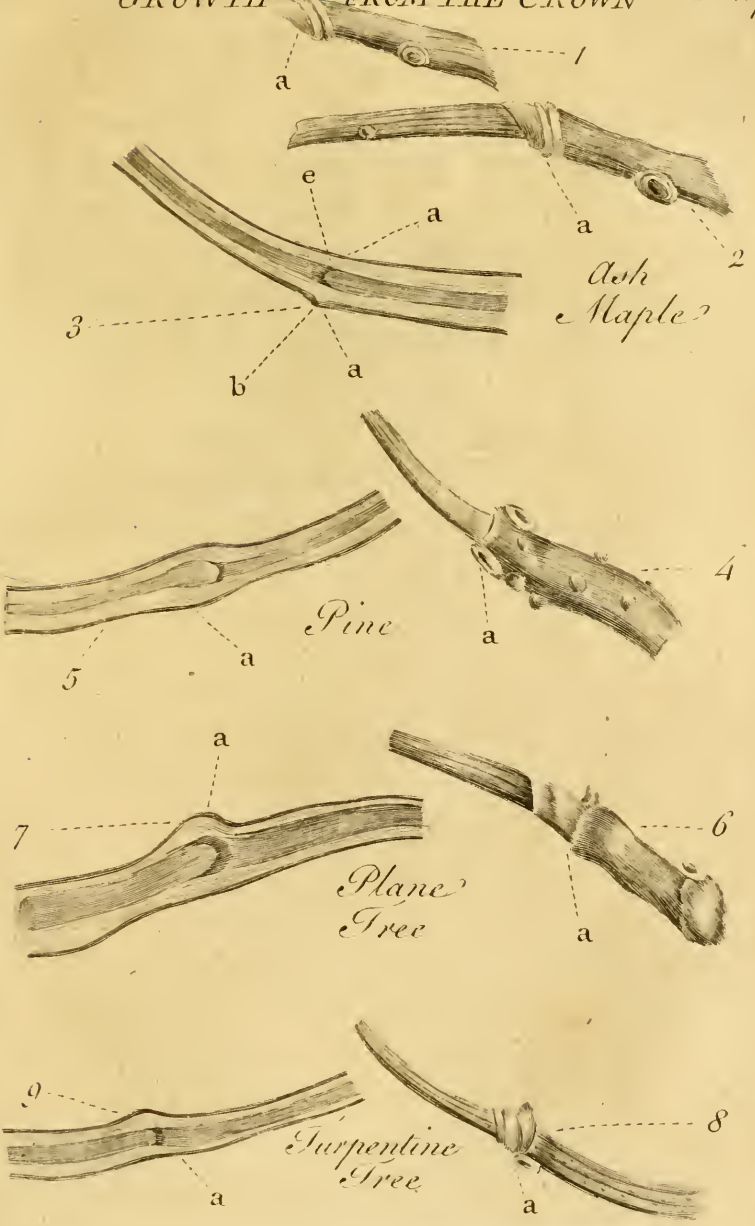
nouriſhment. When the warmth of Spring returns, the Roots ſwell, theſe pores open; thoſe vaſt ciſterns the Sap Veſſels of the Wood become filled, and every thing is nouriſhed and begins to grow: the Shoot extends itſelf thro' its films, and ſeems a young Branch growing from or upon the old one. If we let it take its deſtined encreaſe till May, 'twill then be in a condition to examine as to the nature of its growth, and the condition of its parts. Such a piece is ſhewn at Fig. 2. entire; and at Fig. 3. ſplit regularly open, with the fiſſure carried down into the Shoot of the former ſeaſon. What we ſee in it while whole is, that the top has been well covered with films; and there is an appearance as if the growth had come to an entire ſtop there: but in the ſplit Shoot we ſee 'tis otherwiſe; there is a ſwelling at what was the top, *a a*; but the brown Bark and the white Wood, after thickening in their pauſe, are continued: they aſcend juſt as the Cluſter from the Branch, and leave like that a little ſpace behind them, *e*. In the new growth all therefore is continuous except the Pith: the Veſſels are only lengthened; but the Pith has ceaſed. It comes to an abſolute termination, in an obtuſe form,

as

as in the other inſtances; and after a ſpace is left, Fig. 3. *b b*, a new Pith is generated in the aſcending Shoot, the ſame in texture, form, and colour with that below: but, as has been juſt ſhewn in the other inſtances, perfectly diſunited from it. The new Pith therefore is not a continued growth of the old; but a ſubſtance; produced, as that had been, from the other parts.

In this Maple the Pith has kept its cylindric form throughout, and not thickened at the end with the ſwelling of the top of the Shoot. In the Pine, Fig. 4. where that ſwelling is greater, as it only affects the exterior parts, a greater ſpace is left within than in the former, as at Fig. 5. but if we ſplit ſuch a Shoot, we find 'tis not a vacancy that is left; the Pith fills the larger hollow as faſt as it is formed; for 'tis only at the extenſion in length that its courſe ceaſes.

In the Plane Tree, where the diſpoſition of the Pith is more irregular than in many other kinds, wherever the cavity extends, as at Fig. 6. and 7. *a*. the Pith always goes with it; but ſtill at the place where the Shoot of one ſeaſon ceaſed; and


a
1
a
2
e
a
Ash
Maple
3
b
a
4
Pine
a
5
a
7
Plane
Tree
6
a
9
Turpentine
Tree
a
8
a

and that of another begins, there is a ſpace between the Pith of the former, and that of the latter Shoot: *b*. And even in the Turpentine Tree, Fig. 8. where this ſpace is leſs than in any other which has come under my obſervation, ſtill it is a ſpace, as at Fig. 9. *a*. The Pith of the preceding Shoot ends in the uſual obtuſe manner, where the beginning of that of the young Shoot, altho' diſtinct, is yet irregular.

BOOK IV.

Of the different Diſpoſition of the PARTS in various TREES.

CHAP. I.

Of Differences in the RIND.

THE ſtrength of Trees depends upon the conſtitution of their eſſential parts: their qualities principally upon their ſeveral added Veſſels. The eſſential parts; the Rind, Bark, Blea, Wood, Corona, and Pith, are found in all Trees; tho' differently conſtructed and diſpoſed: but the vaſcular parts, of this additional kind, are not only ſmall and inconſiderable in many, but in ſome are entirely wanting:

wanting: nor is it ſtrange; for every Tree is not deſigned to be medicinal.

The general nature and uſual diſpoſition of theſe parts has been ſhewn in one inſtance, the Oak; in which they are all preſent, and where they lie in their moſt regular form: but in the variety of Trees which God has given for different purpoſes, there are ſo many variations from the general order of diſpoſition and magnitude, that it is pleaſant, in the light of curioſity, to examine them; but there are alſo higher purpoſes to be anſwered by ſuch examination. Since it is to the conſtruction of that part we call the Wood that Timber owes its ſtrength; and to the ſize and contents of the Vaſa propria all Trees owe their powers and virtues; an eye, thus accuſtomed to the viſible differences, will gueſs, almoſt to a certainty, what ſtrange Trees are worthy notice, as to durability; and what promiſe cures for ſickneſs.

To lead to this diſtinctive method of viewing them, it may be proper firſt to ſelect one of the leaſt complex of Trees or Shrubs; the ſimpleſt in its ſtructure:

ſtructure: ſince in ſuch a one Nature will lay open many things in the ordering of the parts, which are hid in thoſe of a more complicated texture.

For this purpoſe, as one of the ſimpleſt of Shrubs, and one readieſt at hand every where, the Dog-Roſe may be ſelected: and there will be found in it, when examined freſh cut, and in the growing ſeaſon, a diſtinction of colour in the ſeveral parts, which marks their outlines very happily.

If a piece of Dog-Roſe be choſen which has finiſhed the growth of one ſeaſon; and has juſt begun that of another, (for in this quick growing Buſh a Shoot acquires in a ſhort time ſome conſiderable thickneſs) a ſection taken from this, of about the two hundredth part of an inch in thickneſs, will exhibit the parts with wonderful clearneſs. Where colour is uſeful, this degree of thickneſs anſwers better than thoſe ſhavings which carry but a thouſandth part of an inch.

A quarter,

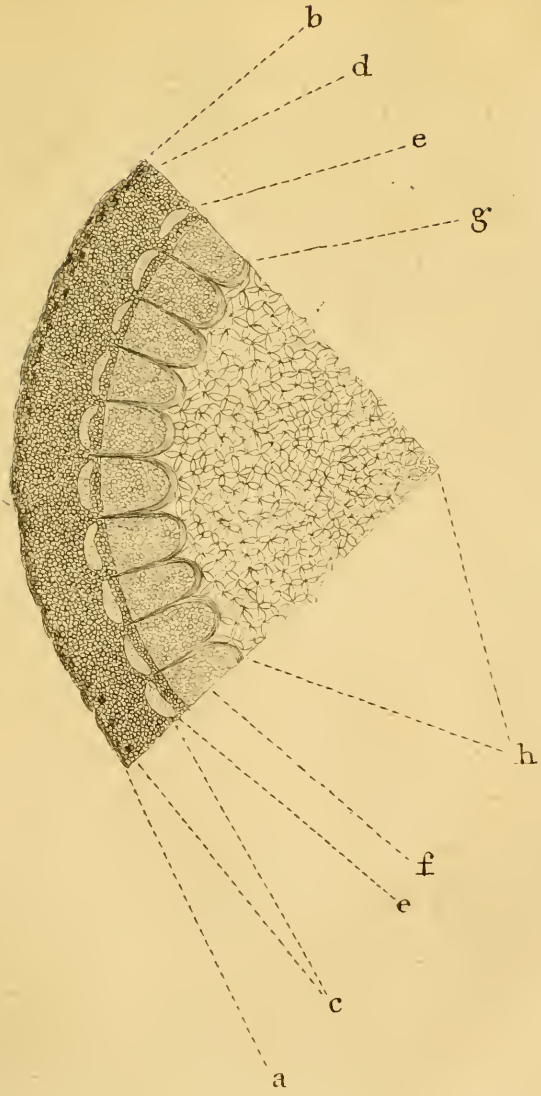
A quarter, cut from ſuch a ſection, and laid before the ſixth glaſs of the Microſcope, appears as at Plate XVIII.

We are to obſerve firſt, the Rind, *a*, which is, in this Shrub, very thick, and ſtands perfectly diſtinguiſhed in ſuch a perpendicular view from the Bark, by its colour: it is a narrow line of white, with ſmall dots, which are the Vaſa exteriora in it; *b*. Within this we ſee a very broad circle, *c*; which is the Bark, very thick in this Shrub, and of a lively green. Theſe parts can never appear in any inſtance more diſtinct. A little way within the inner line of the Rind, lodged in the ſubſtance of the Bark, appear the Vaſa exteriora: theſe are of ſo ſtrong a green, that their colour diſtinguiſhes them from the Bark as much as their form; *d*.

Within the ſubſtance of the Bark alſo, but toward its inner part, and very near the Wood, lies the Blea, *e*, perhaps better to be underſtood in this quick growing Shrub, taken at this ſeaſon, than in any other kind. We ſee it, in moſt inſtances, a pale continuous line be-

tween the Bark and Wood; and ſuch it will become, after a time, in this: but 'tis now in the ſtate of its formation; and appears in ſeveral convex pieces palpably taking their origin from the Wood; and as yet diſunited from one another. Its colour is a pale olive, and its parts are very diſtinct. It is evidently now Wood, yet tender and but half formed, forcing its way into the Bark, which it will thruſt out to the very edge hereafter. The regular green line of Bark, which ſeparates this Blea from the Wood, broad as it now appears, will in half a year more be nothing but that ſlender line which ſeparates and marks the growths of the ſeveral ſeaſons.

Within this laſt mentioned green line we ſee the Wood of the Dog-Roſe, *f:* even that is as yet compoſed of unconnected parts: and by this view of Wood in its infant ſtate, and by no other, can we truly know what it is. It is now a diſtinct ſubſtance, in form of ſeveral ellipſes, of a firm ſtructure, and pale colour. Immediately within the bottoms of theſe ellipſes we ſee the embryo Corona, *g*, conſiſting of a pale convex body, adapted to the ends of theſe


b
d
e
g
h
f
e
c
a

ellipſes, and formed by a ſeparation of the two membranes of their parietes, or ſides.

With what pleaſure will the curious eye, having once acquainted itſelf with all theſe parts in their diſtinct and infant ſtate, purſue them in other inſtances; where, in their adult condition, they have united themſelves for ſtrength one with another; and often loſt even the appearance of their original conſtruction!

The Pith in the Dog-Roſe is alſo a very beautiful object. It has, in a ſlice of this thickneſs, the appearance of ſtarry forms, with oval rays: but this illuſion vaniſhes on cutting a thinner piece. When one is viewed of a thouſandth part of an inch they appear only ſimple Blebs.

CHAP. II.

Of Differences in the BARK.

THE Rind of Trees, being no more than an out-caſt of the Bark, is of little importance to them; and we find in it very little variation: but in reſpect of the Bark it is much otherwiſe. This is a very eſſential part in the Tree; the growth depending, in a great meaſure, upon it; and the qualities: and we find it accordingly very different, in ſubſtance, quantity, and nature, in various kinds.

It is originally the outer membrane, covering the Lobes of the Seed. Even there it may be ſeen, juſt as in the Branch of a Tree, in form of a kind of ſpunge; compoſed of flatted bladders. In the ſucceeding growth, the outer ranges

ranges of theſe bladders, drying, become what we call the Rind; for that part has no exiſtence in the ſeed ſtate: it is formed by the operation of the air; it is ſtretched by the ſwelling of the Wood; and it is caſt off once in a ſeaſon, as ſnakes caſt their ſkins: but not entire, only in fragments. Mean time the Bark remains, covering the more ſubſtantial parts, the Blea, the Wood, and the reſt, and feeding them by a continual ſupply of nouriſhment from its ſpungy ſubſtance; always ſupplied with water: this it draws up freſh as faſt as it is drained off, and continually ſupplies every ſubjacent part. It protects all from external injuries alſo; and defends them from the effects of cold.

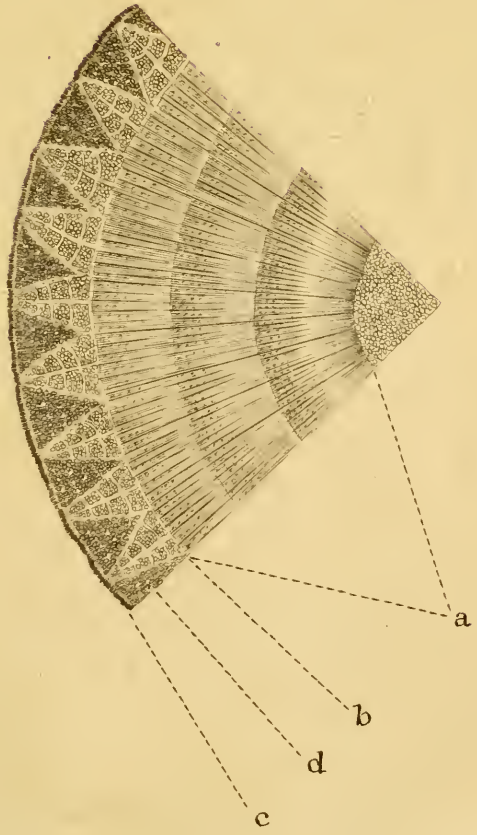
For theſe purpoſes it is variouſly diſpoſed in different Trees. In the hardy and ſlow growing, as the Oak and Cheſnut, it is thin: in the quick growing, as Willow, Poplar, and the like, it is thick: and, what is more worthy yet of regard, is, that altho' it be laid ſmoothly and in an even line over the Blea in moſt Trees, yet in ſome its inner verge is radiated.

There are ſome Trees, and a great many herbaceous Plants, in which this part is continued inward, in form of rays, thro' the Blea, into the Wood; and ſeems to form ſo many green wedges, ſplitting as it were the ſubſtance of both thoſe parts. It would be difficult to conceive how this were done, but that we have ſeen in the Dog-Roſe thoſe more ſolid parts are not originally compact; but compoſed of ſeparate pieces: between theſe the rays of the Bark inſinuate themſelves while they are open, and keep their places, tho' in a ſmaller compaſs, always afterwards.

The Sorbus Legitima, or true Service Tree, affords a very ſtrong inſtance of this: a piece of a tranſverſe ſection of this Tree is given at Plate XIX. This was cut from a Shoot in its fourth ſeaſon: we ſee plainly at the lines of ſeparation, *a a a*, the growths of three perfect ſeaſons: at *b* we ſee the act of growing in a fourth.

The Wood is here, as in the Dog-Roſe, thruſt forward and outward into the Bark; and that not in a continuous ſubſtance, as at *a*, but

Sorbus Legitima



but in detached bodies. They were ſegments of ellipſes in the Dog-Roſe; here they are cones. The brown Rind *c* terminates their ſummits in a regular circle; but the Bark *d* inſinuates itſelf deeply among them, filling up all the ſpace between cone and cone, to their very baſes; and thence continuing itſelf, tho' in a thinner line, thro' every ſeaſon's growth of the Wood, down to the very Pith. This marks out palpably, by its courſe, the ſeveral parts which once were cones of Blea; as the exterior, yet retaining the ſame form of cones, are the true Blea of the Sorbus now: tho' in the courſe of growth their taper ends have ſpread to the ſame breadth with their baſes. Here therefore, as in the Dog-Roſe, and ſome other inſtances, the Blea is always a diſcontinuous ſubſtance; tho' in the generality of Trees it is one ſoft, but entire ring.

The uſe of this conſtruction in the œconomy of Nature is not difficult to be underſtood: an object familiar to me, in infancy, firſt threw it upon my mind. In the park of Sir Francis St. John, at Thorp, near Peterborough, ſtood an old Service Tree, perfectly diveſted of its

Bark, yet growing and full of vigour. I remember a thouſand times climbing it when a boy, and to have heard wiſer perſons ſpeak of it with wonder; that a Tree thus naked could live. I did not, even at a later time, underſtand how it could be, till, taking a cutting from the garden of her Royal Highneſs, this ſtructure preſented itſelf to me. The coat of Bark could be ſpared, becauſe there were rays of the ſame ſubſtance within; which anſwered the purpoſe.

Purſuing this ſubject I have alſo found that the Ciſtus Laurifolia, which has the ſame conſtruction of rays from the Bark, lives very well when peeled; and 'tis familiar that the Plane will do ſo. In that Tree alſo we ſee the ſame conformation; and muſt no longer wonder at the ſame effect. There are many other Trees which have ſomewhat of this quality; and in examining them I have found they have all ſome degree alſo of this conſtruction; and that, (ſo far as can be judged) a degree juſt anſwering to their more than uſual quality of life.

That Leaves and Branches ſhould be produced from a hollow Tree, whoſe Wood had periſhed,

periſhed, tho' the Bark was entire, could not appear wonderful to thoſe who knew the nouriſhment was from the Bark; but that a Tree could live whoſe Bark was gone, muſt ſeem, till this was known, almoſt a miracle.

CHAP. III.

Of Particularities in the BLEA.

THE conſtruction of the Blea has been explained in its place: but its diſpoſition, and the arrangement of its parts, as they are various in different Trees, become now the object of enquiry. The variations of Nature, in this caſe, are endleſs; and there are ſcarce two genera wherein this and the other parts do not differ, more or leſs, either in their quantity, colour, diſpoſition, or arrangement. From the great number of kinds which have paſſed under

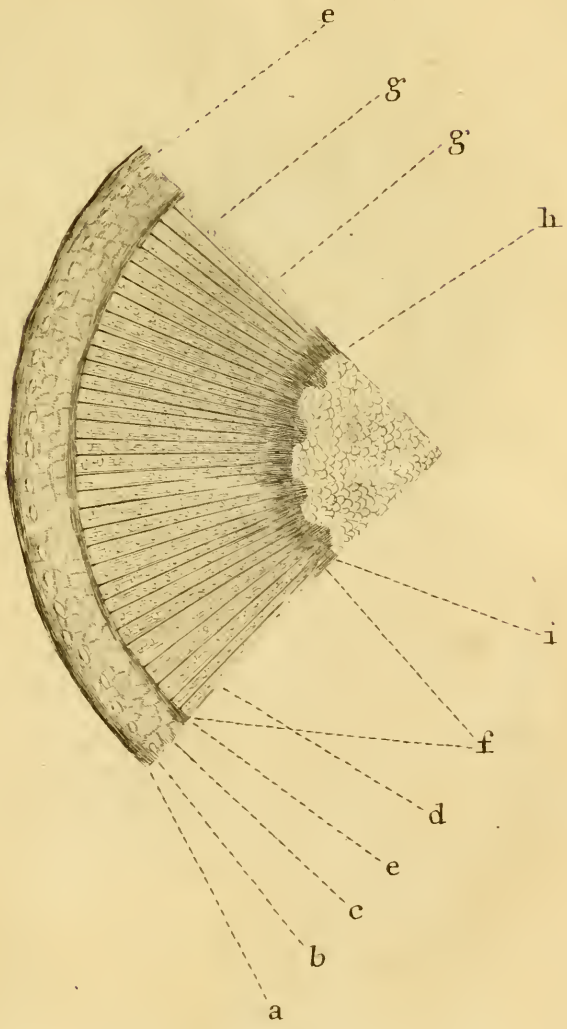
my eye on the preſent occaſion, I ſhall ſelect thoſe where the differences or particularities are moſt conſiderable; and be happy in pointing out to the attentive Reader what Trees, ſo far as this experience leads me, will beſt entertain his eye, and lead his thoughts to more enquiry.

I. Of the plain Diſpoſition of the BLEA in the LIRIODENDRON LILIIFERUM.

When we would ſee the Blea in its plain, moſt natural, and moſt ſimple ſtate, that Tulip Tree which Botanical writers call Liriodendron Liliiferum affords a very fair occaſion. A piece of this is repreſented at Plate XX.

Here the two Barks, *a b*, are very diſtinct; the outer of a deep, the other of a paler brown: and between theſe and the white fleſh *d* is placed at *c* a plain and even circle of the Blea. Its pale brown colour keeps it perfectly diſtinct from the Bark; and its ſtrong inner margin as plainly ſeparates it from the Wood. This is the pure and perfect ſtate of the Blea: and were

LIRIODENDRON LILIIFERUM



were it for the condition of this part alone the Tree would demand a place here: but it has been ſelected for more particularities. Nature is pregnant with wonder and delight; and it has been the care, on theſe occaſions, to chuſe, among the number of thoſe where the main object is equally perfect, ſuch kinds as afford therewith moſt delight or moſt inſtruction, in the other parts. In this the Vaſa interiora, *e*, are very beautifully placed juſt within the inner verge of the Bark: their oblong form is ſingular; and the more ſo, as it is leſs regular and exact than in moſt caſes. The delicacy of the Wood, *f*, and the arrangement of the Sap-Veſſels, *g*, in regular rays, are alſo worthy note; and much more their regular diminution in ſize as they approach the Pith, *h*. 'Tis thus in all Trees, at a certain growth; but ſcarce in any is ſo well ſeen, or takes place in the Shoot ſo early.

It has been obſerved, in treating of the Corona, that the ring or circle of that part wherein the cluſters of veſſels are encloſed is of the nature of the Bark: this Tree gives a plain proof of it at *i*.

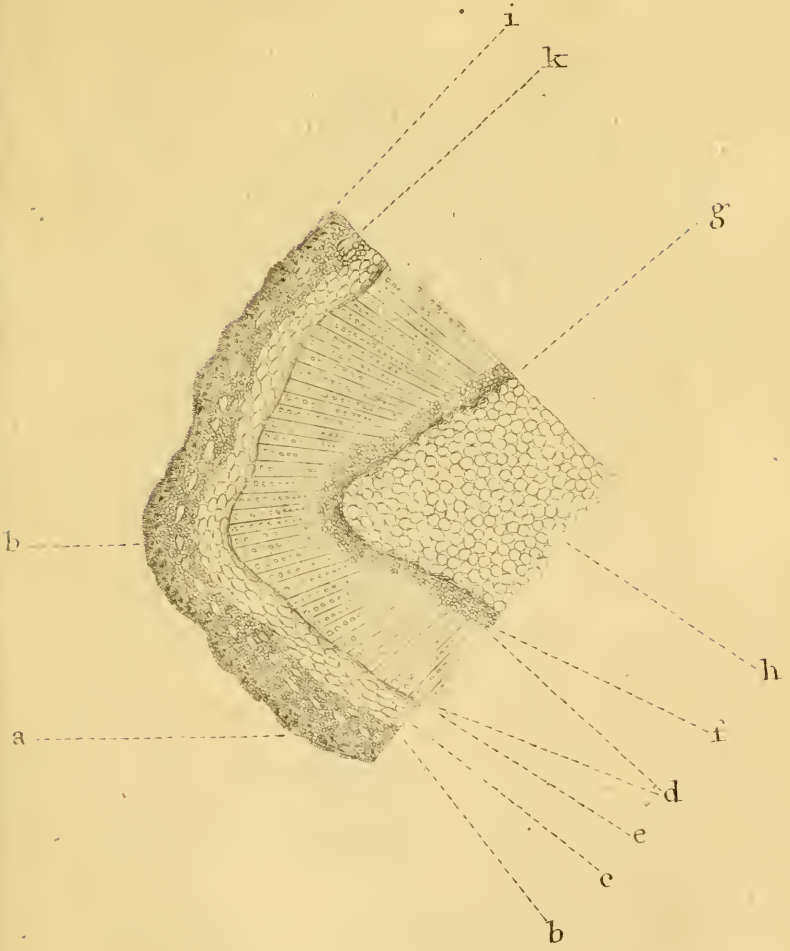
II. Of

II. Of the warped Diſpoſition of the BLEA in the NERIUM OLEANDER.

The Blea of Trees admits of variations from that plain and ordinary ſtate wherein we have repreſented it before, both as to its diſpoſition and conſtruction: in ſome Trees one of theſe differences takes place; in others both. The form of the Shoots in the Oleander is not perfectly round, *a*; and to this the Blea, as well as the other conſtituent parts, conforms itſelf. (See Plate XXI.) In ſhape it is not a circle, as in the Tulip Tree, but a ſwoln ellipſis, ſmaller at the ends, and riſing on each part toward an angle in the middle; and all this with great regularity, *b b*. Its texture is coarſe, *c*, and its colour is a pale brown. The parts of which it is compoſed are the ſame as in all other Trees; for one conſtruction goes through all: but they are in this larger, in their cavities, as well as thicker in their ſides, than in others. The warped ſtate of the line this Blea forms round the Wood, and the regular greatneſs of its parts,

moſt

NERIUM OLEANDER



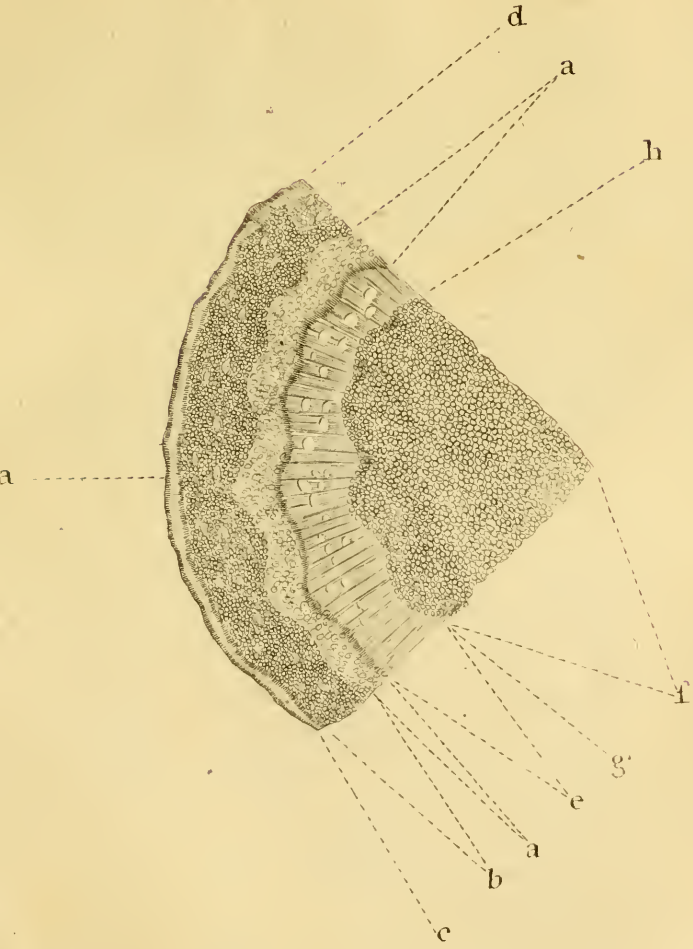
moſt claim our attention: but the object being before us, it were blindneſs not to remark alſo, that the Wood is delicately vaſcular, *d*; that the line which is to mark the growth of another ſeaſon is thicker than uſual, *e*; that the circle of the Corona is palpably of the ſame colour and ſubſtance of the Bark, *f*, and that its cluſters are thrown together more than uſual on the inner ſide, *g*; that the Pith is remarkably large, *h*; and that the Vaſa exteriora, *i*, and interiora, *k*, ſhew themſelves with a diſtinctneſs very pleaſing. There are two rings of the interiora very large and fair, and a perfect line of the exteriora, at the very verge of the Rind. What juice theſe laſt contain it has not been in my power to determine; the former have a milky acrid matter in great abundance.

III. Of the undulated Courſe of the BLEA in the NERIUM ZEYLANICUM.

Purſuing the conſtruction of the Oleander in another ſpecies we ſee by what gradations Nature brings about her changes. The Blea in the

the Nerium Oleander was warped; here it is undulated: there it ran out into four obtuſe angles; here it forms a multitude; a continued ſeries of them: in this, as in the former inſtance, conforming itſelf to the ſhape of the young Shoot; which in the Ceylon Oleander is neither perfectly round or elliptic, but all the way raiſed in an uneven line, or in a kind of ridges and furrows. In the ſtructure of this Blea we find a yet more conſiderable difference: it is a broad line of a pale whitiſh ſubſtance, formed of veſſels with coats ſo remarkably thick, that Nature furniſhes no inſtance equal to it; (ſee Plate XXII. *a a.*) and the ſpungy matter which fills their interſtices is in like manner preſſed cloſe and compact. The colours alſo, in a freſh cut piece, afford a very good opportunity of marking all the conſtituent parts in this Shrub to a nicety; and I hope it will therefore become familiar in the collections of the curious. The Rind is thicker than in moſt things, *b*; and the Bark, *c*, of a very delicate texture: the Vaſa exteriora, *d*, are very numerous, tho' not ſo large as in many others; their quantity making amends for their want of ſize. Their diſpoſition ſeems but irregular; yet

NERIUM ZEYLANICUM



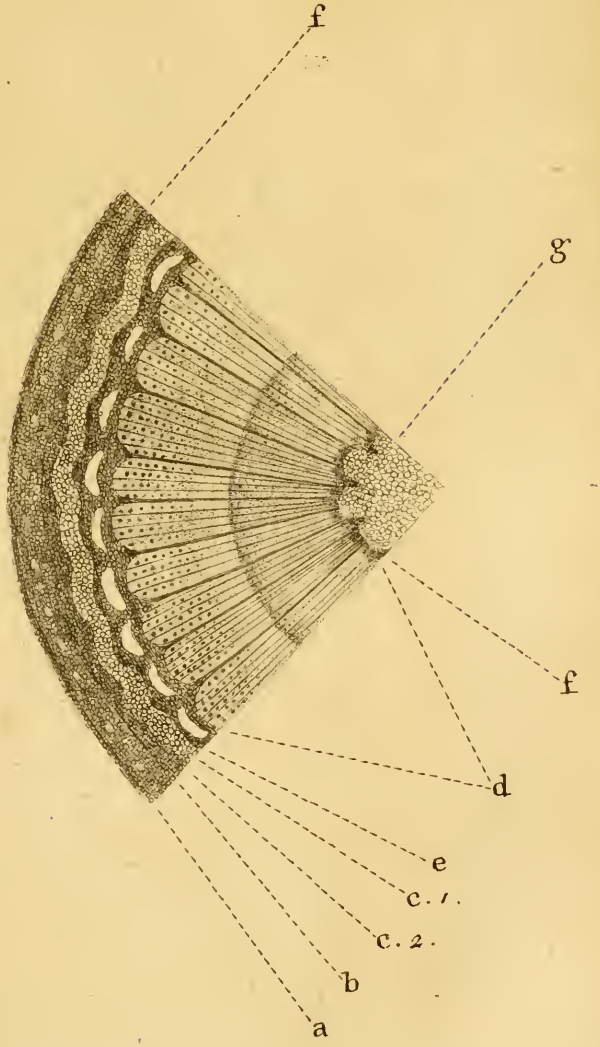
yet a careful eye will count two ranges of them. The Wood, *e*, has fewer Sap-Veſſels than uſual; and, what is much more ſtrange, they are not perfectly round, *f*: the undulated outline of all the conſtituent parts perhaps preſſes upon them. The Pith, *g*, is immenſe, and the Corona, *h*, ſmall: but Nature, conſiſtent with herſelf, has given to the cluſters of that undulated Ring the ſame diſpoſition within the line, as in the common Oleander.

IV. Of the difform BLEA of the EPHEDRA DISTICHA.

We have in this Shrub an inſtance of the ſportings, as it were, of Nature, in the Blea; perfectly ſingular. It is conſiderable in quantity, *a*; it ſurrounds the Wood in that kind of undulated line mentioned in the preceding inſtance; and to a correct obſerver it appears very diſtinctly to be of different textures in its different parts: a line of Veſſels neareſt the Wood, and a mere maſs of confuſion behind it, toward the Bark. This will not be difficultly underſtood by thoſe who

who have firſt acquainted themſelves with the compoſition of the part. We have ſeen it is conſtructed of veſſels and an interſtitial ſpunge. All that is ſingular here is that the ſpunge uſually placed between veſſel and veſſel is kept ſeparate, and thrown behind. A ſection of the Ephedra is given in Plate XXIII. and theſe two parts of the Blea are ſeen at *c* 1. *c* 2. But the Ephedra gives us much more matter of delight and wonder. With reſpect to its Rind and Bark, *a b*; and the diſpoſition of the Vaſa propria interiora, *f*; (for exteriora it has none:) they differ not from what is the uſual courſe: but the Wood, *d*, which is delicately conſtructed, ſhews the diminution of Sap-Veſſels toward the center very diſtinctly: we even loſe them near the inner part of the laſt grown circle of the ſeaſons. But beſide this, that beautiful advance of the Wood toward another of thoſe circles; that which charmed us in the Dog-Roſe, raiſes raptures here. We ſee diſtinctly at *e* the puſhing for a third circle of Wood; and here know how it is formed. The parietes of theſe fruſtrums of cones, which in this object anſwer to the ellipſes of Wood in the Dog-Roſe, are extended in growth before the

EPHEDRA DISTICHA



the matter of the Wood is formed to fill them. It is palpable, in a good view of this kind, that they are well marked, but perfectly empty. The Corona is very beautifully hollowed; and in the Pith are palpable Veſſels. This is the firſt occaſion that has offered of naming them; but we ſhall ſee them in ſome other inſtances. They are the Vaſa intima, ſo ſtrangely diſpoſed; this their ſtructure ſhews, and the firmneſs of their contents. Theſe pierce the Pith in a longitudinal direction; or more probably they are primordial in the ſtructure of the Plant, and the Pith is formed around them.

CHAP. IV.

Of Particularities in the WOOD.

I. Of its ſimple Structure in the Common DOG-WOOD.

A NEW thickneſs of Wood is given to a Shoot at every Spring and Midſummer; diſtinguiſhed by a circle, marking the place where the former ended. The uſual appearance of a ſection in this part is that of a multitude of rays, proceeding from the Blea toward the Pith; cut in many places by concentric circles; at different diſtances. But the number of parts confounds the eye; and to know what the Wood is, we are to ſeek it in ſome ſimple ſtate. No inſtance affords this better than a

ſection

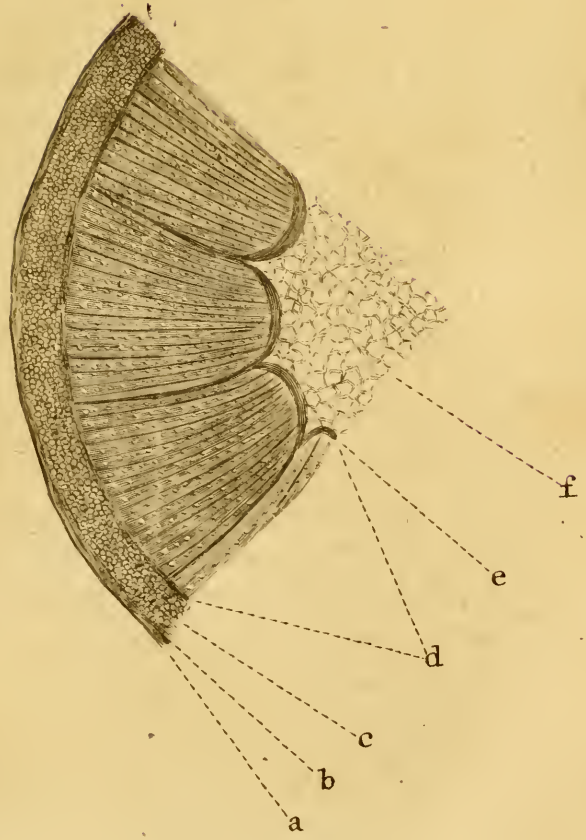
ſection of a young Shoot of the common Dog-Wood. If we ſelect one from a Branch that has had but one ſeaſon for its growth, the appearance it gives before the Microſcope is that figured at Plate XXIV. When we have caſt an eye upon the Rind and Bark, and the broad circle of the Blea, *a b c*, we ſee the great, plain, and noble ſtructure of the Wood at *d*; and find at *e*, what we had before ſeen in the Dog-Roſe; that the Corona, howſoever afterwards it be filled, takes its original from the parietes or ſides of thoſe obtuſe broad cones which here are what the ellipſes are in that other Shrub. And it is palpable that here in the Corona, juſt as in the protruſion for a ſecond ſeaſon's Wood, theſe parietes are the firſt part that grow. They form the ſpace which there is to be filled with the matter of the Wood; and here, by a much more complex and wonderful ſubſtance.

The Wood is in this inſtance the moſt plain and ſimple thing imaginable; and its parts being naturally large, and not preſſed together as in the harder kinds, can be viewed diſtinctly, and eaſily underſtood. We now ſee that the Wood,

which in old hard Trees we look on as one maſs, is formed of cones, with baſes tending outward, and each cone perfectly incloſed in a thick ſhell, of a matter more compact by far than the intermediate ſubſtance. Within theſe cones run multitudes of rays, all like the parietes of the cones, converging inward; and in reality each two of them forming a leſſer cone, within the larger. Within this leſſer cone, between theſe rays, is depoſited the ſubſtance of the Wood, pierced with innumerable holes; or, in a more juſt way of ſpeaking, giving place to a multitude of Veſſels. Theſe are the Sap-Veſſels. The intermediate ſubſtance is the moſt compact part of the Tree: and this is always the real ſtructure of that part; however it may in various inſtances ſeem to ſhew a wonderful variety. The Pith of the Dog-Wood, *f*, is, as the reſt, the ſimpleſt we can look upon; a mere collection of hollow cells crowding and preſſing upon one another.

If this conſtruction of the Wood, which is ſo eaſily underſtood in the preſent inſtance, be always held in mind, as we examine others, the

DOGWOOD



the ſecrets of the compoſition will be laid open to us with leſs pain.

II. Of the Length of the Cones in the ACACIA DECIDUA.

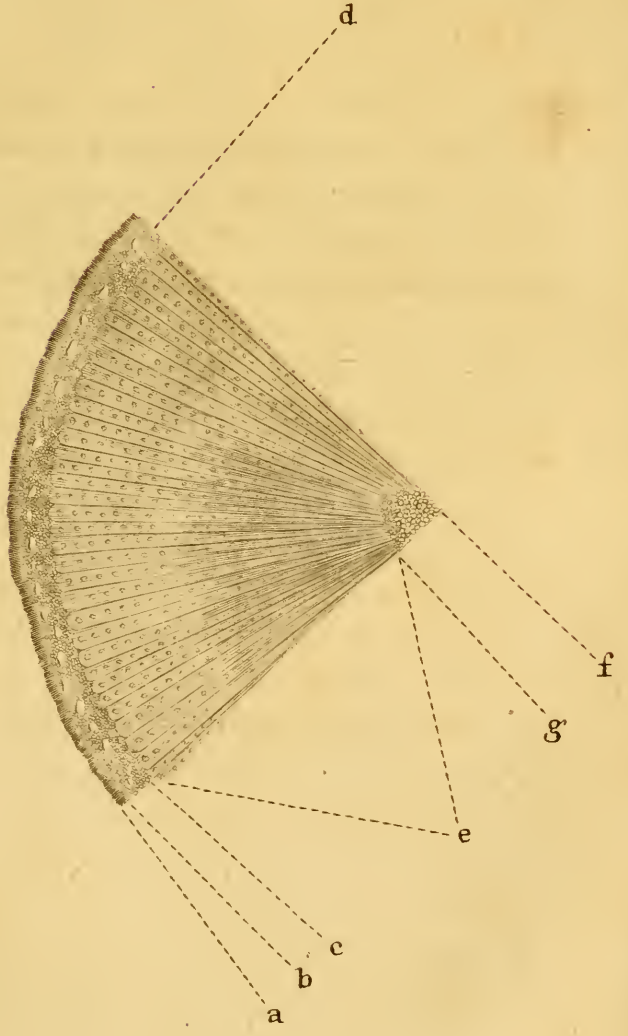
A Tree which affords an inſtance of equal ſimplicity with the Dog-Wood, but in a new form, is the Acacia Decidua: a ſection of which is given at Plate XXV. yet the ſmallneſs, or, if it may be better underſtood, the delicacy of its parts renders it leſs obvious; and leads us, as by a ſingle ſtep, from that ſimple kind to the appearance of the more complex. The Rind in this Acacia is very thin; the Bark is alſo thin; *a b:* and in the Blea, which holds ſome breadth at *c*, are diſpoſed Veſſels ſo very much reſembling the interiora of other Trees, that we ſhould ſuppoſe them of the ſame nature, if we did not firſt ſee them in a place where the intima alone can ſtand; and if the firmneſs of the matter with which they are filled did not confirm it: but beyond all, their own ſtructure:

for they are ſimple Veſſels; their ſides are not vaſcular.

The Wood, which lies nearly within theſe, conſiſts of very long and narrow cones. The parietes of theſe are extremely diſtinct, tho' fine; and the whole Wood is pierced with Sap-Veſſels ſo large, that its own vaſcular ſtructure, which is indeed in all Wood very delicate, affords the idea of a compact and ſolid ſubſtance. Nature, in this inſtance, giving all to the Wood, contracts the Pith, and half annihilates the Corona: 'tis very ſingular: but ſtill the parts of that circle are to be ſeen in theſe young Shoots of the Acacia Decidua: and in thoſe of more ſtanding they become as large as uſual. Why and to what end Nature, where nothing is done in vain, gives this exuberance of Wood to this, and the ſcanty ſtore of it to Dog-Wood, are queſtions for a very high philoſophy.

III. Of

ACACIA DECIDUA.



III. Of the thick Parietes of the ROBINIA CARAGNA.

He who will join with me to purſue the laſt named plan; and try if it may be found why, in the Robinia now before us, the ſides of thoſe caſes wherein the Wood is held are remarkably thick, or, if we may uſe ſo ſtrange a word, ſo coarſe; will perhaps open the way to a knowledge of the nature of Trees, which, tho' propoſed more than two thouſand years ago by Theophraſtus, has paſſed thro' the hands of all his ſucceſſors untouched, ſo far as their writings have informed us; therefore, at leaſt, not happily followed.

The appearance of a ſection of this Tree is given in Plate XXVI. In the Rind and Bark, *a b*, nothing is particular. The Blea is very firm, compact, and delicate. In the Wood there are, as it were, ſhadows of circles; nothing real: but ſtill we find the Sap-Veſſels diſpoſed according to the ſame diviſions. The great

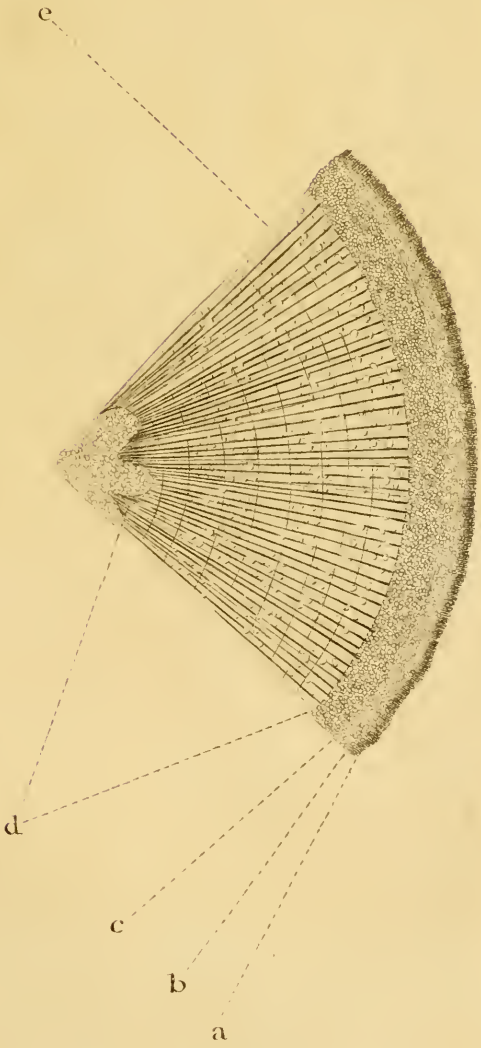
ribs which mark the ſeparate cones are objects indeed of wonder; thick, firm, green, and ſtrait as lines drawn from the circumference by a geometrician! It ſeems as if the effort of Nature in the conſtruction and growth of this Tree had been placed here; and that theſe ribs had outgrown the diviſion of the ſeaſon circles. Thoſe circles mark the ſtops of growth between the Spring and Midſummer encreaſe: it ſhould appear therefore that this Tree owned no diſtinction of thoſe ſeaſons; but that it continued equally at all times growing on. 'Tis ſingular in many things; in nothing more than this.

The Corona is ſmall, but regular; and in the Pith are Veſſels, ſtuffed, as the intima always are, with a concreted juice, like a hardened reſin.

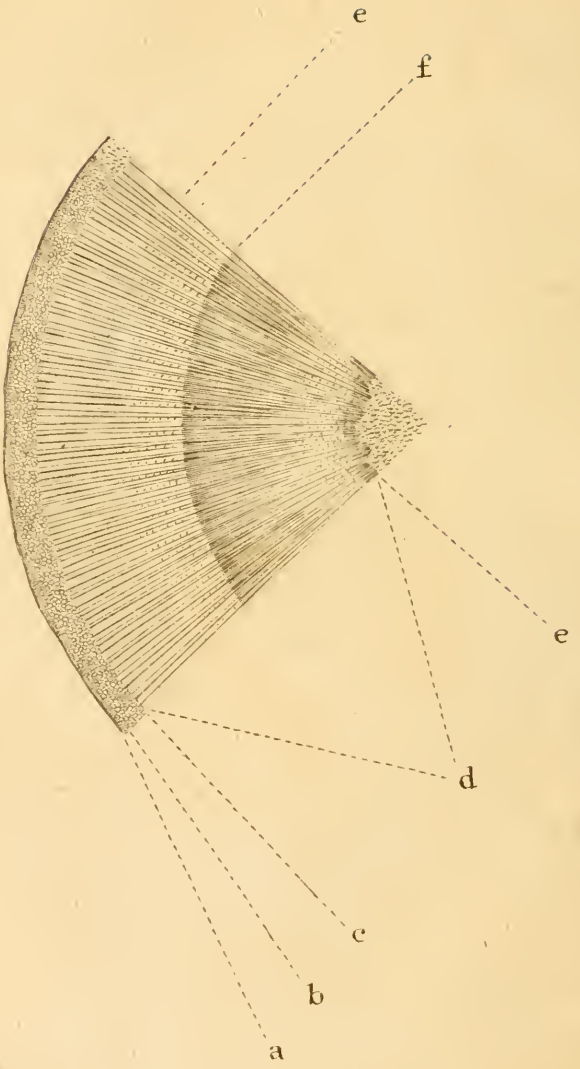
IV. Of the broad Seaſon Circles in the ARBUTUS.

The parts we wiſh to note in Trees for their ſingularity are beſt ſhewn by oppoſition. In the Robinia Caragna the circles of the ſeaſons ſcarce exiſt:

ROBINIA CARAGNA



ARBUTUS



exiſt: in the Arbutus, a Tree which few exceed in delicacy, they are yet remarkably conſpicuous. A view of this is given in Plate XXVII. In the Rind, the Bark, and the Blea, *a*, *b*, *c*, nothing is particular; but in the whole conſtruction of the Wood there is a delicacy which fancy ſcarce can reach. There is much more: there is a diſpoſition of the Sap-Veſſels ſtrange and unuſual; they are largeſt toward the baſe of every circle, and become obliterated gradually to the verge. In the common courſe it is quite otherwiſe: but the line *f*, the mark of diſtinction between the encreaſe of a former and a latter ſeaſon, is, in the Arbutus, thickened beyond what we ſee in moſt kinds: and even the exterior part of the firſt circle from the Corona is thickened with it. The Corona, *e*, partakes of the delicacy of the whole ſtructure of this beautiful ſpecies; and, tho' ſmall and thin, and more than in moſt other kinds tranſparent, affords a view of all its conſtituent parts very perfect, and very lovely.

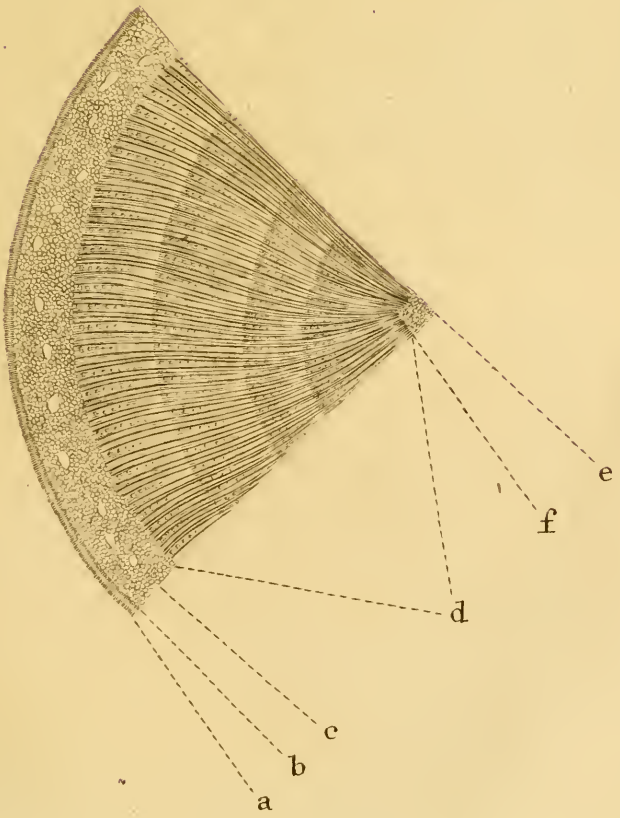
V. Of

V. Of the uneven Lines in the Wood of the THUYA CHINENSIS.

Our attention was demanded, in a preceding inſtance, by the perfect regularity in which the lines formed by the parietes and inner diviſions of the Wood were drawn from the circumference to the center, even with a mathematical exactneſs: we have here a proof how much Nature can deviate from what might ſeem her deſtined rules; yet without altering the conſtruction of thoſe portions with the diſpoſition of whoſe component parts ſhe wantons. A ſection of the Thuya Chinenſis, the China Arbor Vitæ, is one of the moſt delicate objects that can be placed before the eye: in this manner 'tis repreſented at Plate XXVIII. The rays or lines which divide the Wood into innumerable ſmaller cones are here thrown into an eaſy wave, which, taking its riſe from the inner line of the Blea, bends downward in the new circle, then riſing in the ſecond and third, takes again its firſt courſe in the innermoſt; and this with

an

THUYA CHINENSIS



an eaſy bend that is very pleaſing. All the time the parts are as diſtinct, and their quantities and proportions are as regularly kept, and as well obſerved, as if the lines had run with the moſt perfect ſtraitneſs. For the reſt, what is obſervable in this fine Tree, is, that the Pith is extremely ſmall; the Corona very delicate, but finely formed, and it runs into deeper angles than is uſually ſeen: the Sap-Veſſels of the Wood are largeſt in the youngeſt parts of it; and the Vaſa propria exteriora are very diſtinct.

CHAP.

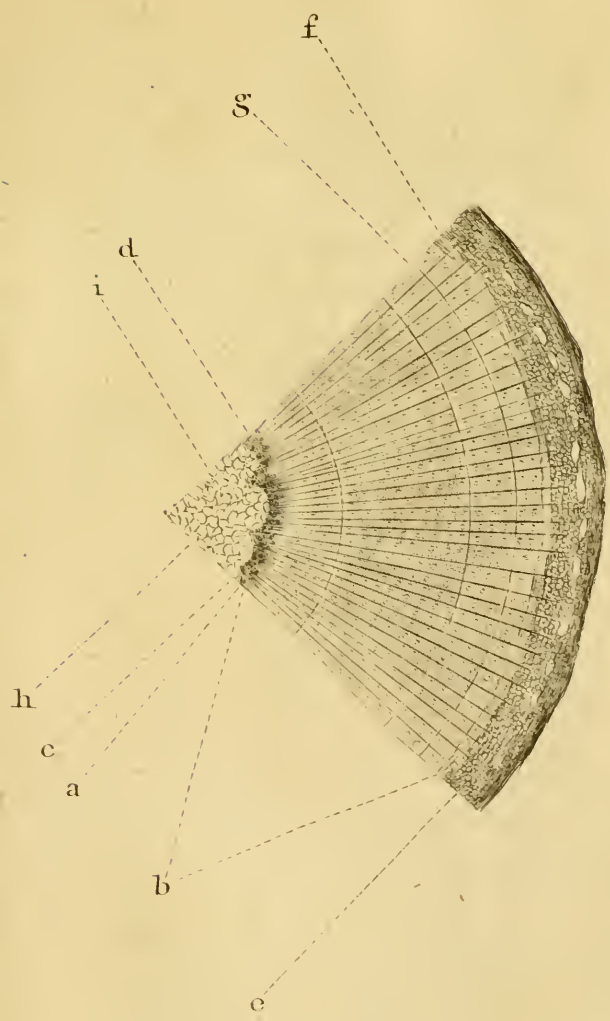
CHAP. V.

Of Particularities in the CORONA of TREES.

I. Its Plainneſs in the CISTUS LAURIFOLIA.

THERE can be no doubt but the conſtruction of this eſſential part is perfectly the ſame in all Trees: the ſtricteſt obſervations, and the powers of the greateſt glaſſes, join to ſhew this: but here, as in the Wood, and elſewhere, altho' the parts are invariably the ſame, their diſpoſition differs wonderfully. In the Ciſtus Laurifolia, Plate XXIX. the Corona is little more than a plain ring, *a:* in which, however, we ſee eaſily the ſimple ſtructure of the

CISTUS LAURIFOLIA.



the Bark in the outer part, *b*, unmixed with other matter. In the portion next the Pith, that darker line it firſt exhibits, *c*, ſhews, when viewed with due advantage, the cluſters, *d*, on which all future encreaſe depends. For the reſt, the coarſe form of the Blea, *e*, is ſingular in this Shrub; as is alſo the thickneſs of that line which terminates the Wood toward the Blea, *f*. The Sap-Veſſels, *g*, in the Wood itſelf are ſmall, but finely diſpoſed; and in the Pith, *h*, there are ſome cluſters of the Vaſa intima, *i*, whoſe contents are leſs compact than thoſe veſſels uſually have them.

II. Of the Exterior Prominence of the Cluſters in the MAGNOLIA GLAUCA.

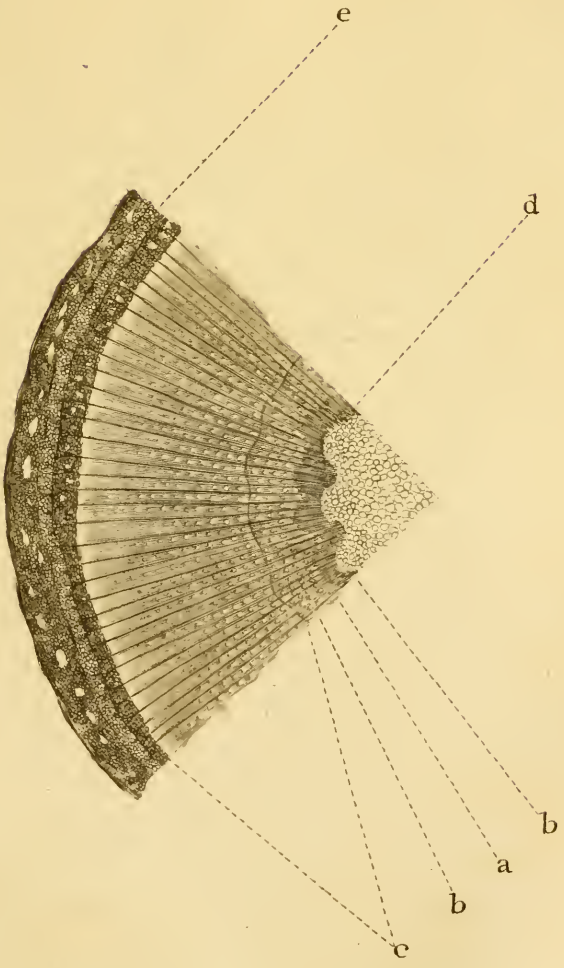
The Circle in this beautiful Tree does not carry the ſimple outline of the Ciſtus: its cluſters are not buried in its ſubſtance. The whole of the Corona of this Tree, a ſection of which is given in Plate XXX. is of an undulated form, *a*; and its wavy prominences, *b*, which are but ſmall toward the Pith, ſwell out into

into the form of obtuſe and unequal cones toward the Wood, *c*; whoſe firm texture gives way to them, and leaves them their appointed figure. Into each of theſe prominences is carried one diſtinct and perfect cluſter, *d*, wherein all the parts are very viſible, and the Veſſels of the different orders are moſt diſtinctly ſeen. The view here given was taken with one of thoſe wonderful glaſſes made by the Pere de Torre, placed in the apparatus of the double Microſcope, inſtead of the tube. Nothing could ſhew an object more diſtinctly; and the reverend father deſerves the higheſt praiſe; whatever fate prevented his receiving it from our Royal Society: whatever blindneſs, or malevolence there, injured his fair fame.

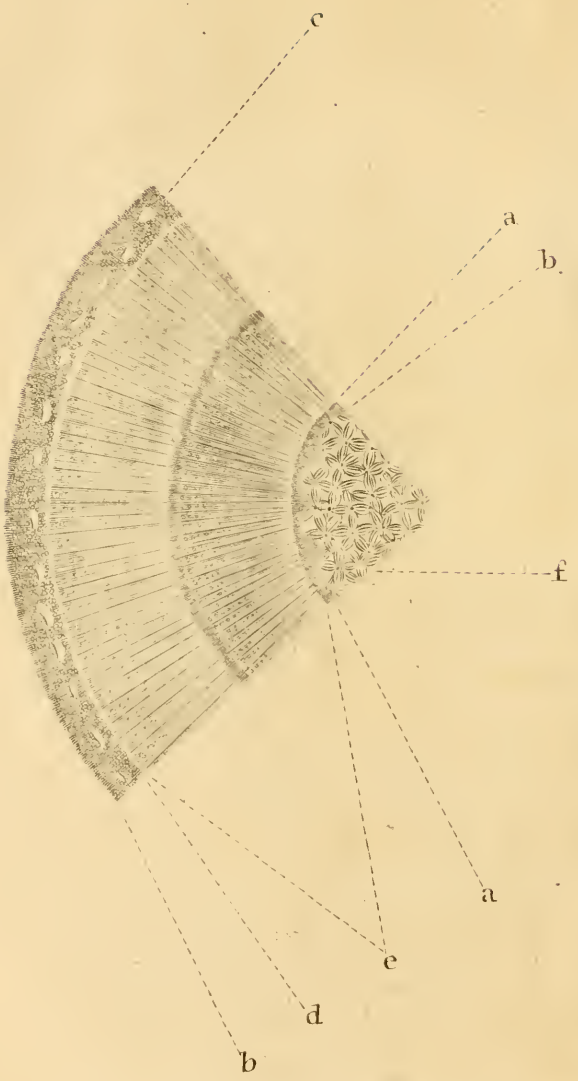
What is obſervable farther in this noble object is, that the Blea, *e*, has in it a regular and connected chain of vaſt veſſels, perhaps exceeding the Vaſa intima in any other Tree; and that behind theſe, in their proper place, the ſubſtance of the Bark, there is alſo a regular courſe of very large Vaſa propria interiora. Theſe promiſe virtues in the Tree; for they contain thick juices: but they are yet unknown.

III. Of

MAGNOLIA GLAUCA



STAPHYLÆA



III. Of the Interior Prominence of the Cluſters of the CORONA in the STAPHYLÆA.

The common Bladder-Nut, Plate XXXI. affords the Microſcope, in this way, an object of great beauty; and, in the conſtruction of the Corona, *a*, the part here under immediate conſideration; it is of proper ſingularity alſo to follow, in the mind's eye, that of the Magnolia. That circle here riſes, as there, into protuberances, in form of obtuſe cones: but, as in that Tree, they are thruſt outward into the Wood; here they project inward, and form an indented line about the Pith, *a b*. Each of theſe protuberances, as in that inſtance, contains one of thoſe cluſters from which the encreaſe of the Tree is made by new Branches.

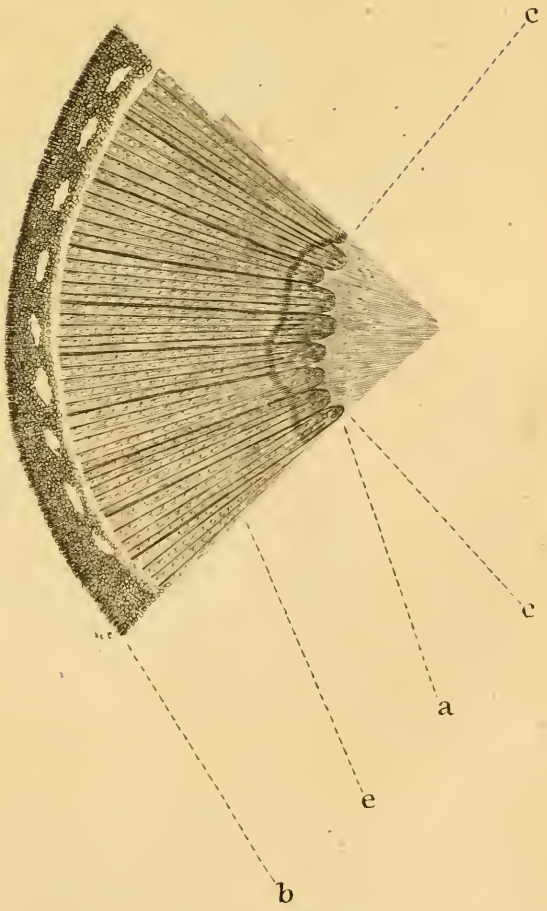
The Bark in this Tree alſo is delicately conſtructed, *b*; and in it are a ſeries of very beautiful Vaſa interiora, *c*. The Blea, *d*, is almoſt nothing; a mere white line ſeparating the

the Wood from the Bark. The Wood, *e*, is delicate; and the Pith, *f*, being formed of ſhallower Blebs than in many other kinds, affords a very pleaſing mixture of double, treble, and quadruple lines; in various figures.

IV. Of the Projection inward of the Cluſters in the PLUKNETIA VOLUBILIS, in Form of Cylinders.

The undulated line, with the protruſion of its riſings into a kind of cones, is not the higheſt effort we ſee in Nature, under this head. The Pluknetia, Plate XXXII. affords us an inſtance where thoſe protuberances, every one of which is as it were the coat or ſhell of a cluſter of propagation, form themſelves into abſolute cylinders; and ſeem continuations of the parietes of the cones of Wood; making at leaſt the outline of thoſe caſes. The circle, *a*, of the Corona here is plain and perfect Bark; no way to be diſtinguiſhed from that at *b* but by the ſmallneſs of its parts: but the protuberances,

PLUCKNETIA VOLUBILIS



berances, *c c*, altho' they carry the ſame kind of outline with the Wood, *d*, are perfectly different in their contents.

It has been obſerved before, that the outline of the Corona is always firſt formed by a duplicature of the ſides of the Wood cones; and what we ſee in this inſtance is an evidence of that conformation, the traces of which remain longer than in moſt other Trees. The conſtruction of this Tree does not in any thing elſe material differ from the uſual courſe, unleſs it be in a ſuperior degree of regularity and diſtinctneſs of lines; *e*.

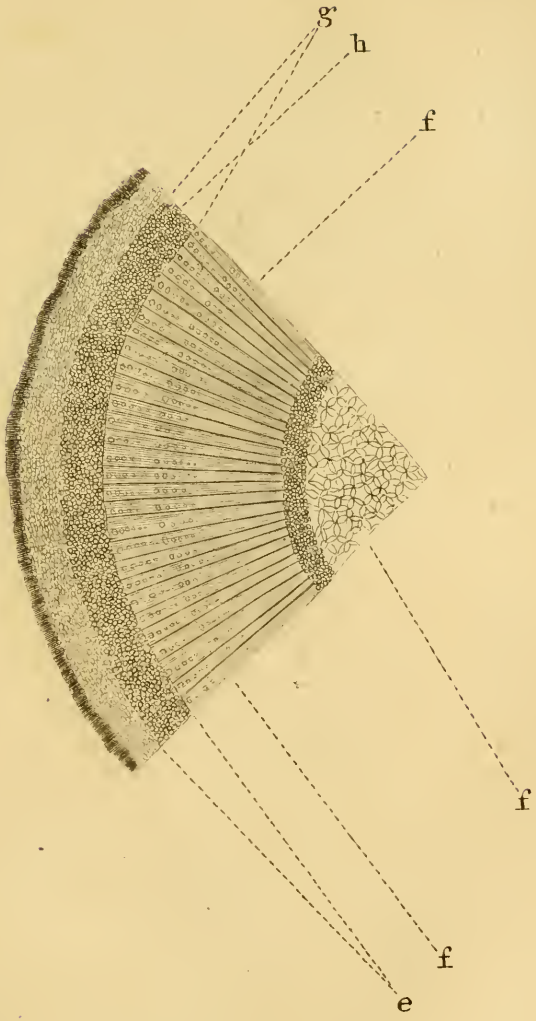
CHAP. VI.

Of Particularities in the PITH.

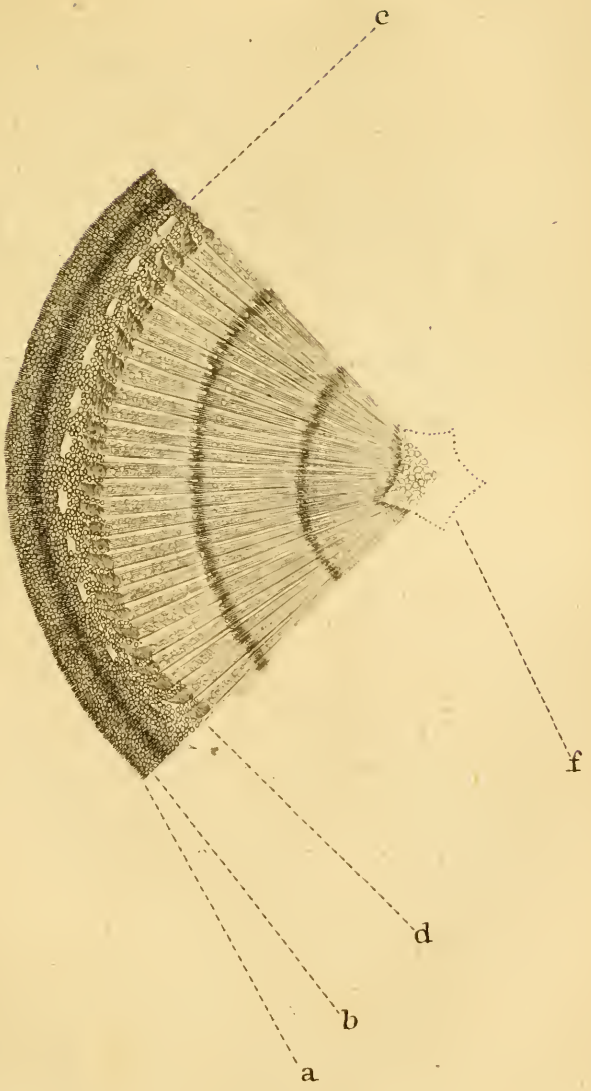
I. Its plain State in the ANNONA SQUAMMOSA.

THE Pith, lying immediately within the Corona, muſt in all caſes take its form from the interior outline of that part; for 'tis too ſoft to have given the figure to the Corona: not to ſay that it is always poſtnate, and was not in being when that line was formed. In the Annona, Plate XXXIII. we ſee it in what may be called its ſimpleſt and moſt natural ſtate. It fills a regular circle exactly in the center of the Branch, and has neither protuberance nor indenting, *f*; and it affords all that delight

ANNONA SQUAMMOS



ALMOND



delight to the eye in viewing, that a Pith is capable to give; for its cells are very ſhallow, and the films that form them very delicate: ſo that in viewing a piece of about an hundredth part of an inch in thickneſs, ſuch as is repreſented here, we ſee thro' a vaſt multitude of them at once, whoſe outlines interſecting one another give cobweb-like ſtars; and forms of great variety and beauty.

For the reſt, the Annona is no trifling object. Its Blea, *e*, is greater in quantity and more diſtinctly formed than almoſt in any other Tree. The Wood is regularly diſpoſed, and pierced by numerous Sap-Veſſels, *f*: and in the ſubſtance of the Blea, *g*, are Vaſa intima, *h*, greater than in many other kinds.

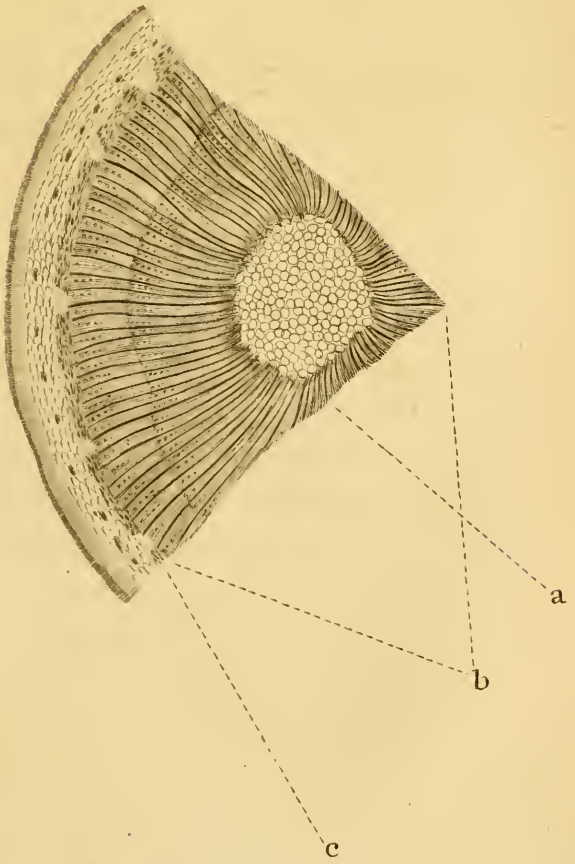
II. Of the Pentangular Form of the PITH in the ALMOND.

We need not always ſearch the ſtoves for Trees or Shrubs to afford delight in this examination; our gardens, nay in many inſtances

the hedges, afford them. If elegance of ſtructure alone were ſought, and beauty were the object in purſuit, ſcarce any kind affords it in a degree beyond the Almond. But beſide this, it has alſo great ſingularity; and is in many parts moſt worthy of obſervation. Plate XXXIII.

In moſt Trees the Pith, conforming itſelf to the other coats, takes the ſame ſhape with the outline of the Twig. 'Tis round we have ſeen in the Annona, and in the Oleander 'tis elliptic, and angulated; in each caſe, anſwering to the ſhape of the Shoot: but tho' the Twig of an Almond Tree be round, the Pith is pentangular; *f.* This form is given it by the Corona; which, tho' extremely narrow, yet preſerves that ſhape with the moſt trim exactneſs. The Pith anſwers in delicacy to the Corona; and is tender, thin, tranſparent, and very prettily figured. But in the Almond there is more worth notice: the two Barks, *a* and *b*, are thicker than is uſual; and in the ſubſtance of the latter lie oval Vaſa interiora, *c*, of great note. The Blea, *d*, is formed of little cones turned toward the ſun, and between theſe runs in a quantity of Bark, ſeparating alſo for a little

Petræa Conifera



way the cones of Wood. The Almond ſhould therefore be in Nature another inſtance of a Tree that may ſurvive when peeled: and what it may be, that it is: many Almond Trees at Denham ſhew it. The Wood in the Almond is delicate; but as the Barks are thick, ſo are the lines which divide the circles of the ſeaſons.

III. Of the PITH of the PETRÆA CONIFERA; not Central.

The ſportings and the wantoneſſes of Nature, (if ſuch expreſſions may be uſed on unoffending ſubjects) have been ſpoken of: doubtleſs what vain philoſophy has taught us to call by the idle name Luſus Naturæ are things referable to cauſes that would exclude the term, if they were known. But howſoever that may be, the Petræa Conifera, Plate XXXIV. gives a very ſtriking inſtance of this kind. One would ſuppoſe, if any thing could be called certain about the Pith, it would be its central diſpoſition: at leaſt it might be thought ſo in reſpect of young

Branches; for they have not been in the way of thoſe accidents which might have thickened one ſide of a Trunk at the expence of another: but here we ſee that great diſpoſer placing, even in the youngeſt Shoots, the Pith far on one ſide of the Bough, *a*. The Petræa affords us alſo an inſtance of one of the ſimpleſt Piths, ſurrounded by a Corona as little conſiderable as in any other: but in the Wood of this Tree, *b*, there is as much ſingularity in conſtruction, as of the Pith in place. That part is formed of very broad, very obtuſe cones, whoſe parietes take that wave ſo delicate in the Thuya Chinenſis; and conſequently the interior lines have alſo the ſame turn. This adds not a little to the prettineſs of the object, when a ſection of the Tree is viewed: but there is more to be obſerved on this head: the Blea, *c*, is very conſiderable in quantity, and pierces the Wood between the greater cones; juſt in the way the Bark has been ſhewn to do in many Trees. It were well if this ſpecies were more common, that we might ſee whether or not the Blea could ſerve the purpoſe of the Bark in its growth; for here, as the Bark is perfectly ſeparated

ſeparated from the Wood, if on the peeling a Branch of Petræa it ſtill continued to grow, we ſhould know the Blea can ſerve the office of that part, as well as that which is immediately its own.

BOOK V.

Of Particularities in the VESSELS of TREES.

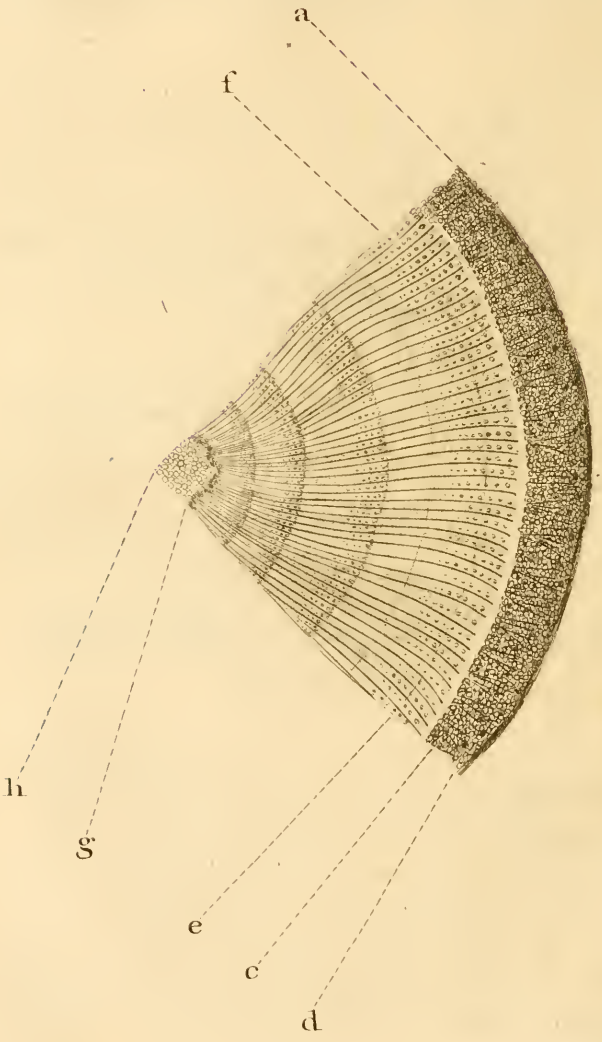
CHAP. I.

Particularities in the VASA PROPRIA EXTERIORA.

THERE is no part of the Vegetable Conſtruction ſo little liable to variation, as far as I have yet ſeen, as this of the Vaſa propria. Their form and diſpoſition in the Oak has been given already; and that is, in almoſt every Tree, the true ſtate of their arrangement.

They

AMERICAN CYPRESS



They are often too ſmall to be very obſervable: the eye frequently miſſes them, unleſs aſſiſted by ſome new power of glaſſes: and when it finds them, they are juſt what they were in kinds that offered them more eaſily to the view. Only in the American Cypreſs, repreſented at Plate XXXV. I have ſeen a difference: and 'tis there indeed a great one. In other inſtances they are packets of little Veſſels; tender, thin in the coat, and filled with ſome tough juice. In this Tree they are ſingle tubes, *a*, their coats are firm, they riſe up above the ſurface of the reſt of the parts when the ſection has lain cut a little while, (that is, they contract leſs than the other parts, which therefore recede from them,) and they are more than filled; at leaſt 'twas ſo at the ſeaſon, April 17. when I examined them, they run over, with a moſt pure and perfect balſam; nay they ſhew their ſides, tho' thick, unable to reſiſt the force with which this has been thrown up into them: for they appear burſt in many places.

For the reſt, this Tree is not without its particularities. The Blea, *c*, riſes in cones; and the Bark, *d*, forces itſelf between them; but

but does not penetrate the Wood, as in ſome other inſtances. The texture of the Wood, *e*, is very delicate; and the Sap-Veſſels, *f*, are numerous, but not large. The Corona, *g*, in this Tree is ſmall, but very correctly defined; and the Pith, *h*, is extremely thin.

CHAP. II.

Particularities in the VASA PROPRIA INTERIORA.

I. Their ſingle Diſtribution and ſmall Number in the LARIX.

OF theſe important Veſſels, (important in their uſe to man, tho' as it ſhould ſeem leſs ſo than many other parts to the growth of the Tree,) we ſee a great variety, in number, diſpoſition, and contents: but in all, whatever may be their difference of ſize, their ſtructure

ſtructure is the ſame. To underſtand them beſt, the way is to ſee them where they are ſimpleſt and moſt diſtinct. The common Larch Tree is here ſelected for that purpoſe. In the ſection of it, Plate XXXVI. we ſee, in the great ſubſtance of its Bark, *b*, the mouths of a few Veſſels; few, but very large. They are very conſpicuouſly diſtinct; and ſerve, in this light, to that moſt uſeful purpoſe, the clearing up a doubt, which ſome who have gone thro' theſe obſervations with me had entertained.

The vaſtneſs of theſe Veſſels in ſome Trees had rendered them ſuſpected not to be ſuch, till I ſhewed turpentine exactly filling and ouzing up from them, on cutting in ſome kinds of Pine: and in others their ſituation without the centers of diſtinct cones of the Wood, confounded them in the imagination with thoſe protruſions of the parietes which are, as has been ſhewn, the beginnings of encreaſe in that part. But here alſo the Larix afforded a diſtinct anſwer to the doubt. The Wood of this Tree, tho' extremely delicate, *d*, is not formed into large cones at all, but diſpoſed between the ſeveral radii only: yet here appear theſe vaſt

openings,

openings, *c*, as in other caſes; and they are filled with a very ſingular kind of liquid maſtick.

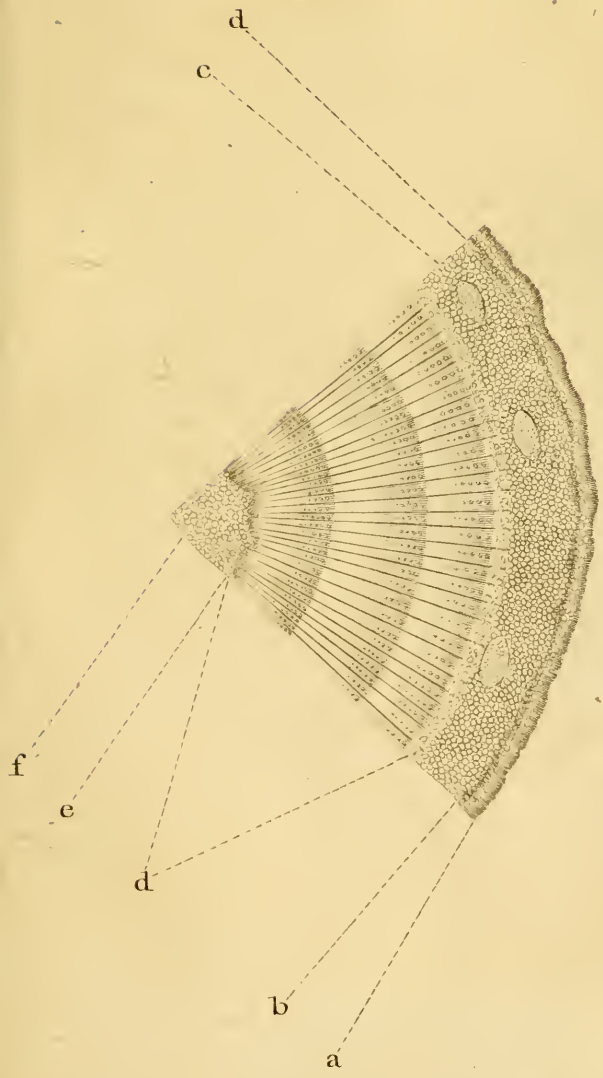
For the reſt, the Larix affords a very pleaſing and inſtructive view. The Rind is thicker than in moſt Trees; and cloſe within its verge, between that and the Bark, are lodged the Vaſa exteriora, *d*, in long and ſlender cluſters, which at the laſt-mentioned ſeaſon diſtinguiſh themſelves eminently by the juices they contain, they being of a high crimſon. The Corona, *e*, is very beautiful in the Larix; and its Pith, *f*, is clear.

II. Of their cloſe Diſpoſition in the TANACETUM FRUTICANS.

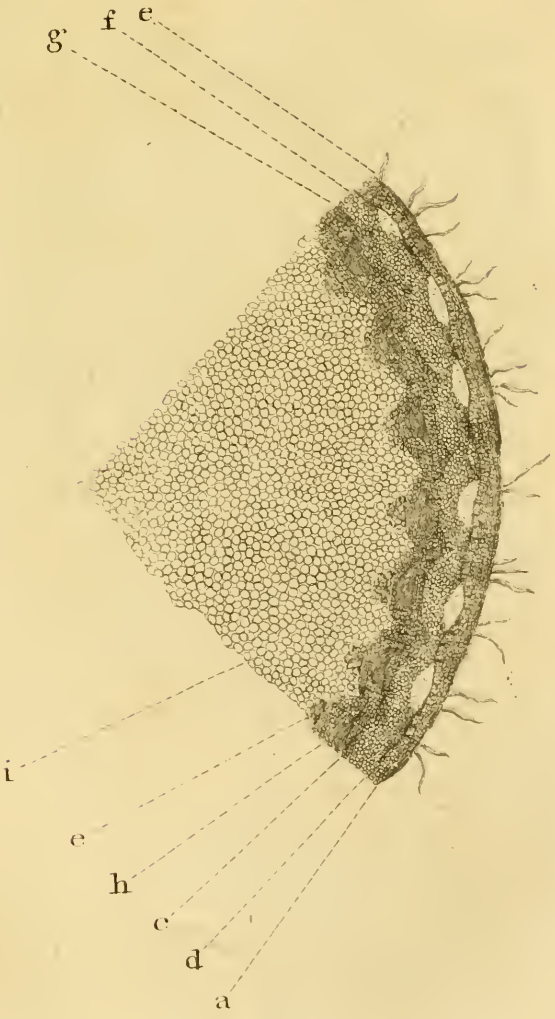
The number of theſe Veſſels may be much greater, tho' in a ſingle ſeries, than we have ſeen them in the Larix. The Tanacetum Fruticans, a ſection of which is given at Plate XXXVII. is an inſtance of this diſpoſition. In this ſingular Shrub, which ſo far approaches

to

LARIX



TANACETUM FRUTICANS



to the herbaceous kinds as to be almoſt all Pith, we ſee them in the ſubſtance of the Bark, at *b*, extremely large; and placed ſo near, that the circumference, inſtead of three or four in a quarter, here contains ſix or ſeven; the Plant having from twenty-four to twenty-eight in the circle of the Bark. In the reſinous, and in ſome of the gummy Trees, we always find theſe Veſſels filled with their proper juices. In this Shrub I have, on the contrary, always found them empty, *c*: but near them, and behind them, are diſpoſed other Veſſels, *d*, large, tho' not like theſe, and cloſe arranged in a regular connected line: they are at all times filled with a peculiar juice; tough, fragrant, firm, and coloured. Nature has not allotted the ſingle ſeries of Vaſa interiora, as by an inviolable law belonging to all Plants; we ſhall ſee them, in a ſucceeding inſtance, in much greater quantity: and here, tho' it be leſs diſtinct or obvious, the caſe is juſt the ſame.

The farther particularities in the Tanacetum Fruticans are not a few or ſlight ones: glands, *e*, in the form of hairs, hang on its outer Rind; a thing common in the herbaceous tribe, tho'

it

it be leſs ſo in Trees. The Blea, *f*, forms an undulated line, of a cloſe texture; and immediately within that ſtands what there is of Wood, *g*; a thin looſe circle, formed not into cones, but oval bodies, and ſeparated by the matter of the parietes, run out into a kind of ſpunge, and forming a regular circle under the Blea. The Corona, *h*, is a circle of more than uſual circumference; and Nature has allotted it accordingly to be very thin: and the Pith, *i*, which is of the ſimpleſt kind, by far exceeds in quantity all the reſt together.

III. Of the various Series of the VASA PROPRIA INTERIORA in the PINUS CEMBRA.

If the place of the ſupernumerary Veſſels, in the preceding inſtance, could lead us to a doubt whether they were or were not in reality of the nature of the Vaſa exteriora; what was there conjecture, here amounts to certainty. The Pinus Cembra, a ſection of which is given in Plate XXXVIII. beſide its ſingle range of immenſe

immenſe Vaſa exteriora, *a*, placed in the uſual way in its thick Bark, has two or more leſs orderly ranges of Veſſels, palpably of the ſame nature: and even beſide theſe there is a ring of ſmaller Veſſels, *b*, ſurrounding, at a little diſtance, each of the larger. 'Tis happy that in this Tree the juice which fills the great Vaſa propria is ſo pure and fine a turpentine, ſo abundant in its quantity, and ſo peculiar in its ſmell, that there could need no more or better teſt whether theſe other Veſſels were of the ſame kind, than whether they did or did not carry the ſame peculiar juice. The tip of a pencil touched upon their open mouths determines this perfectly.

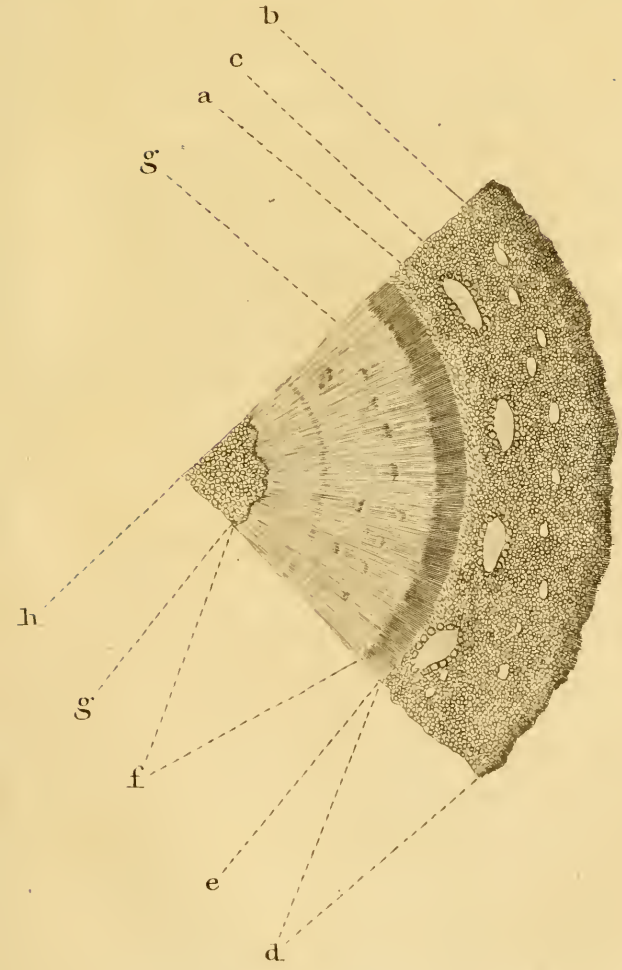
What there is farther obſervable in this Tree, is, that the Rind, *c*, is thick, which indeed is leſs unuſual in the reſinous Trees than thoſe with watery juices; that the Bark, *d*, is alſo very thick, and very delicately formed; the cells being more diſtinct and yet with thinner edges than in moſt Trees: the Blea, *e*, is a firm, duſky, compact circle. The Wood, *f*, on the other hand, is tranſparent to a degree ſcarce ſeen in any other Tree, except thoſe of its own genus,

and

and pierced with a conſiderable number of Sap-Veſſels, *g*. In theſe, during the months of March and July, there is a watery ſubacid juice, a true Sap, untainted by the peculiar medicinal juices of the Tree; and at other times they are entirely empty: no turpentine being ever found in them, unleſs forced into their open mouths from ſome other part of the Tree. The Corona, *k*, is a thin but very diſtinct and elegant circle; and the Pith (which is not uſual unleſs in reſinous Trees) is coloured and clammy. Balſamic Veſſels, containing a peculiar turpentine, a yellow kind, of a coarſer ſmell than the reſt, riſe thro' the Pith. Theſe, in the cutting, ſhed a part of their contents, which ſpreads among the bladders of the Pith; and gives the whole that colour and that flavour.

CHAP.

PINUS CEMBRA



CHAP. III.

Particularities in the VASA INTIMA of TREES.

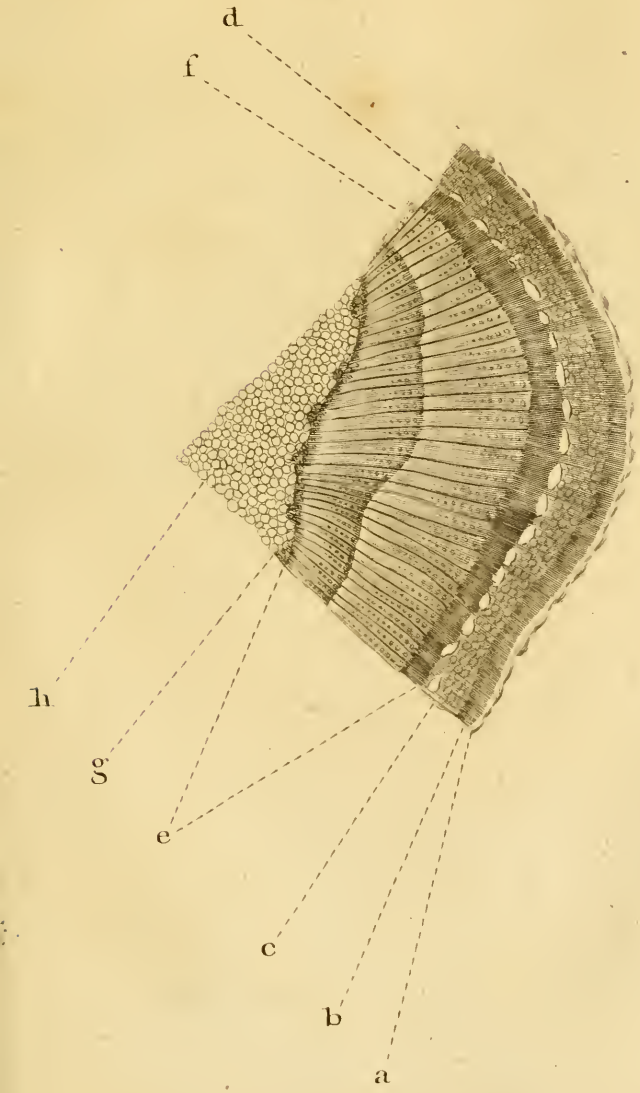
I. Their ſimpleſt State in the HELIOTROPIUM ARBORESCENS.

AS the Vaſa intima of Plants have their proper place in the ſubſtance of the Blea, never being found in any part exterior to that, tho' ſometimes farther within; we may judge that to be their plaineſt and ſimpleſt ſtate where they are found in a ſingle ſeries in that part; and only there. Such an inſtance is the Tree Heliotrope, Plate XXXIX. This is one of thoſe kinds which are warped to the ſun, and in which all the inner coats conform themſelves

ſelves in ſhape to the exterior ſhape of the Branch: and conſequently form in their outline not circles, but irregular and waved ellipſes. The Rind and Bark of the Heliotrope, *a b*, have nothing in them peculiar, unleſs it be that the Rind is more uneven than in many others. The Blea, *c*, is vaſt, and toward the inner part of it is placed a range of oval Veſſels, *d*, filled with a thick, white, acrid juice, of the nature of what are called gum reſins. Within theſe Vaſa intima the Blea is more compact by far than near the Bark; and within this lies the Wood, *e*, beautifully pierced with round mouths of Sap-Veſſels, which in July, when I laſt cut the Shrub, were ſo abundantly replete with a ſouriſh water, that they floated all the ſection with it, and ran over every way at its edges. The Corona, *f*, here is a very delicate line, clear, except where the cluſters of the Veſſels are placed; and the Pith, *g*, is large and plain.

II. Their

HELIOTROPIUM ARBORESCENS



II. Their repeated Series in the PISCIDIA CARTHAGENENSIS.

The fineſt view that it is poſſible to obtain of the Vaſa intima of Trees, is that of the Piſcidia Erythrina, given before; where the Veſſels were examined as to their ſtructure, in Plate XIII. but this other Piſcidia, tho' much inferior to that, is not without its ſingularity or beauty.

We have ſeen, in the Heliotrope, theſe Veſſels lodged in their proper place, the Blea: Nature has there allotted to the Shrub a ſingle line of them: here we have two, *a b*; and the ſecond is in a place altogether ſingular, the Corona. The firſt and more natural ſeries of theſe Veſſels is ranged in the centre of the Blea: they are oval, large, and full of a juice, of a ſtrong green, utterly unlike and diſtinct from all the other contents of the Branch. The repeated ſeries occupies a conſiderable ſpace in the plain Corona of the Tree, where they have alſo loſt their oval form. They are perfectly cylindric, as is the moſt natural ſhape of

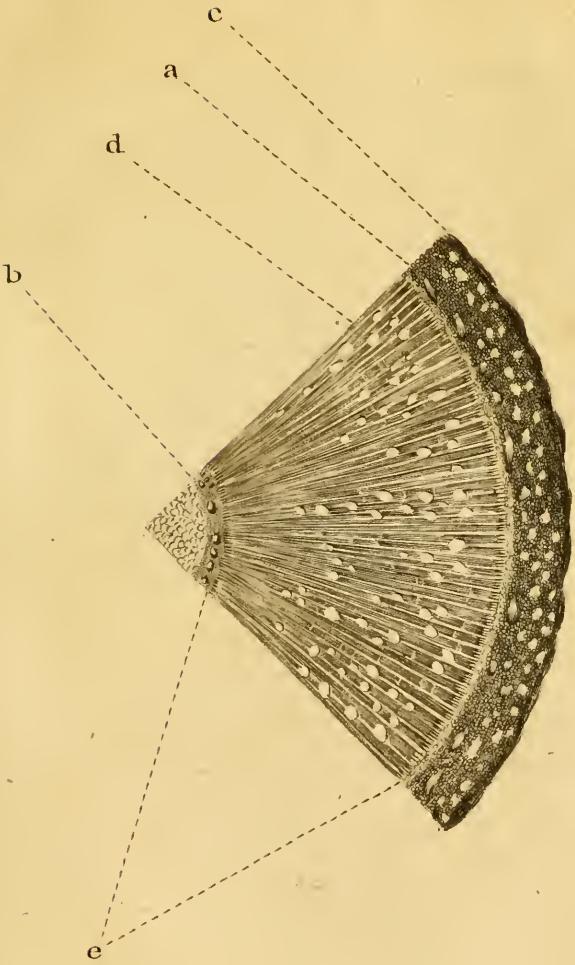
theſe veſſels; and one would be led to doubt their nature, were it not aſcertained by their contents; the ſame very green hard juice filling them.

What is farther obſervable in this ſpecies, is, the extreme number both of the Vaſa exteriora, *c*, and of Sap-Veſſels, *d*. There are ſeveral uneven ranges of the firſt in the ſubſtance of the Bark; and the latter occupy, with the ſame irregularity, a very great part of the Wood: yet this Wood, *e*, pierced as it is like a cullender, is not light, but very heavy. We ſhould wonder at this, had not the familiar inſtance of the Oak taught us, that the ſtrength and weight of Timber is not affected by theſe apertures.

III. The central Diſpoſition of them in the HEMLOCK SPRUCE FIR.

We have ſeen the Vaſa exteriora enter the Pith, and ſtain it with their contents, in the Pinus Cembra: and howſoever it be out of the common

PISCIDIA CARTHAGENENSIS



common courſe to ſee the Pith of Trees pervaded by longitudinal Veſſels, yet the Fir, known by the name of Hemlock Spruce, will ſhew us that not the exteriora alone, but the intima, can find their way thither. A ſection of this Tree is given, Plate XLI. The exterior range of theſe Veſſels is formed, juſt where it ſhould be; in the Blea, *a*: they are ſmall, but diſtinguiſhable enough to an accuſtomed eye: they are perfectly round; their coats have a remarkable thickneſs; and they are ſtuffed full of a firm, red reſin, not a little reſembling what druggiſts call dragon's blood. In the Pith we meet with Veſſels, *b*, round in their outline, perfectly diſtinct in form from the cells of the Pith, and filled with this ſame red reſin. It is impoſſible not to recognize the Vaſa intima in theſe: they ſtain the whole of the Pith, in cutting, with this juice: but the ſlight colour that acquires by accident, is very eaſily to be diſtinguiſhed from the deep and coarſe contents of the Veſſels themſelves.

While this ſection is before us, it is impoſſible but we muſt ſtop to admire the beautiful conſtruction of the Wood, *c*, formed of lines drawn

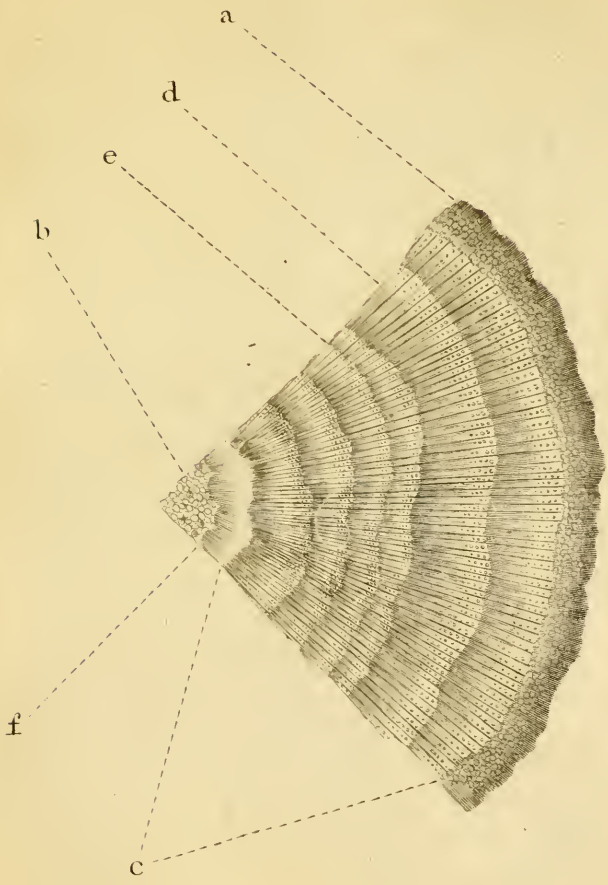
with a more than mechanical exactneſs, and encloſing little cones, *d*, pierced with innumerable Sap-Veſſels, *e*. The Corona, *f*, protuberates inward; and, in a thin ſlice, is very diſtinct.

CHAP. IV.

Particularities of the Coronal VESSELS: Their diſtinct Appearance in the SUMACH.

IT has been ſhewn that the Veſſels of the Corona are not different from the ſeveral Veſſels of the former kinds, only that they are here in a ſmaller compaſs, and of leſs ſize. They need not be deſcribed particularly after thoſe; for greater and leſs is no diſtinction in philoſophy; nor have theſe any other. Yet, as there is in Sumach an opportunity laid before the curious eye

HEMLOCK SPRUCE FIR



eye of being certified of this truth, it may be uſeful, as well as agreeable, to ſhew it.

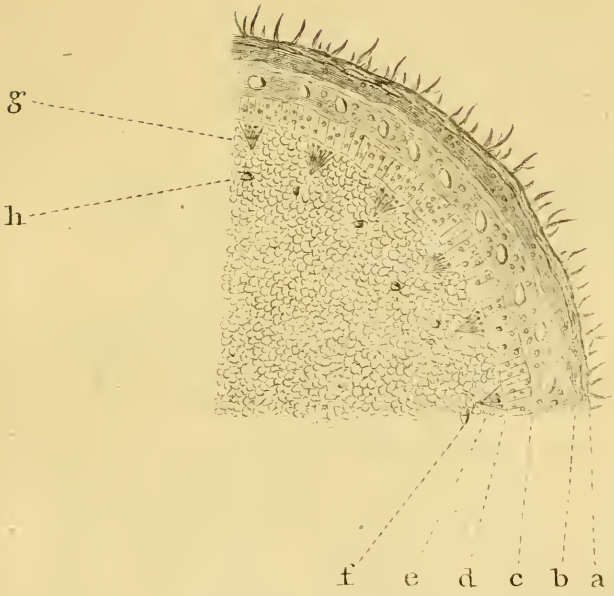
A ſection of this Tree is given, Plate XLII. where the firſt ſight will ſhew how much it approaches to the herbaceous tribes, in the glandular conſtruction of its Rind, and in its vaſt Pith. Happily in this Tree the Corona makes a more diſtinct circle, more defined in itſelf, and more ſeparate in its parts, than is to be ſeen elſewhere. When we have followed the conſtruction of this Shoot from without; and ſeen its brown and hairy Rind, *a*, lined by the dark green juicy Bark, *b*, and within this the paler, yet green Blea, *c*, we diſtinguiſh very finely the ellipſes of Wood, *d*; and within theſe the Corona. Its white circle, *e*, has let looſe, as it were, the cluſters, *f*; and one of theſe, ſeparated, waſhed clean, and viewed by a greater power of glaſſes, appears as at Fig. 2. where the Rind and Bark, thrown to the ends, 1. 2. ſhew dots at 3. which are here the embryo Vaſa exteriora; and larger ſpecks at 4. the interiora. At 5. in that which is to be the Blea, are dots, tho' ſmall, yet particular in colour; and 'tis impoſſible, both from that and

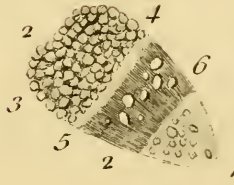
from their place, to doubt their being Vaſa intima in miniature: and in the central part, at 6. are Sap-Veſſels, whoſe openings, as is the caſe in moſt other inſtances, are ſo big as almoſt to look prepoſterous.

The Vaſa exteriora, in the entire ſection, cannot but be admired; they are firm, full of a milky juice; and when the ſection, if of any thickneſs, has lain but a few minutes, they riſe from its ſurface, being too ſolid to ſhrink with the reſt. In the Pith, at a ſmall diſtance, within the cluſters of the Corona, *g*, are to be ſeen, very beautifully, purple Veſſels, *h*, whoſe form and ſtructure ſhews them Vaſa intima.

CHAP.

SUMACH





CHAP. V.

Of the Diſtribution of the SAP-VESSELS, particularly in the OAKS.

TO form a proper judgment of theſe Veſſels, too much miſunderſtood by many, we can no where follow them better than in the Oak; the firmeſt, ſtrongeſt, heavieſt of Trees; yet pierced beyond all others by theſe tubes. They have been ſhewn in their natural ſtate in Plate III. in the common Engliſh Oak: and that ſize and diſtribution of them, however ſtrange it might ſeem to an unaccuſtomed eye, is not peculiar to the ſingle ſpecies. Nature is uniform in all her works; and tho' there be few Trees, if indeed any, that have theſe openings ſo large and numerous as the Scarlet and the Engliſh Oak, yet in all ſpecies of

of that Tree they are very nearly alike. In the Scarlet Oak of America, ſo pierced with them as to be unfit to contain, in veſſels made of it, any thing but dry goods; they ſtand much as in our Engliſh kind, only not quite ſo regularly. A view of this is given, Plate XLIII. There is a ſort of triple row, *a b c*, formed of them in the Wood of each ſeaſon, but not correctly.

The Spaniſh Oak affords them in double rows.

In the Ever-green Oak they have no circular direction, but run down obliquely croſs-wiſe.

In the Cheſnut Oak they are thrown into rays.

And in the Red Oak, not the Scarlet, croſs-wiſe.

But in all theſe ſpecies the proportion of aperture to ſolid is very nearly kept up, except in the Scarlet, where it is much greater than in any others. In the reſt, where the Veſſels are largeſt, there are feweſt of them; and where ſmaller, their number makes amends for their want of ſize.

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